Iron and Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

AUGUST, 1949

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MODERN HIGH SPEED COLD MILL . . .

. . . designed and built by MESTA

Mesta 56" Four-High, Five-Stand Tandem Cold Mill Installed in a Large Canadian Steel Plant.

Color Photo by E. D. MESTA

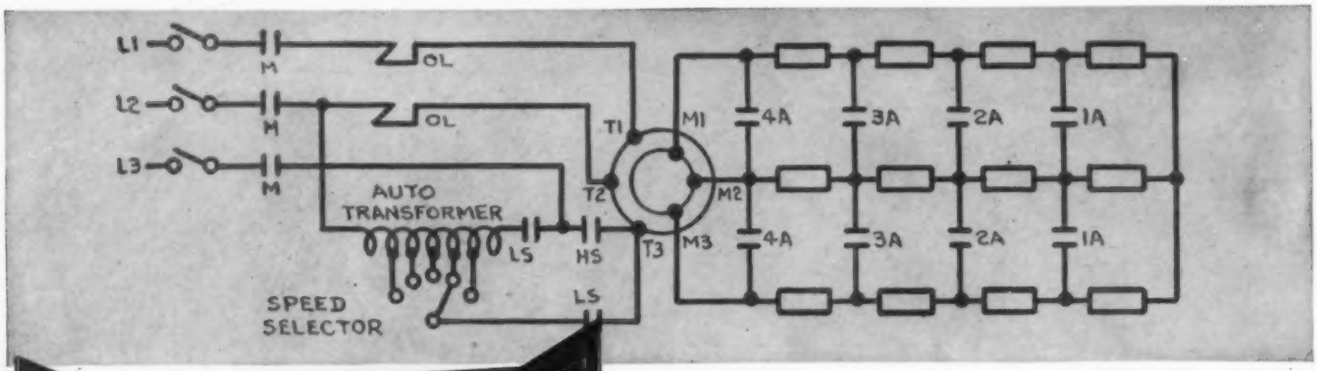
DESIGNERS AND BUILDERS OF COMPLETE STEEL PLANTS

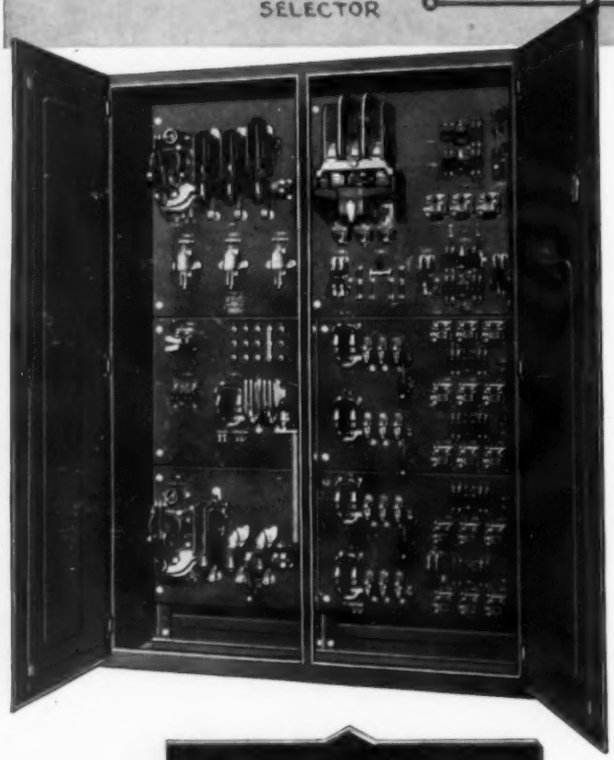
MESTA MACHINE COMPANY · PITTSBURGH, PA.

What control for what mill equipment?

One of a SERIES

of advertisements featuring basic heavy duty power circuits . . . and showing Cutler-Hammer's broad design and application experience which has made it the preferred control for the steel industry.





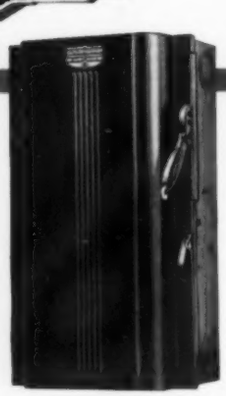
Where an A-c installation calls for stable slow speed and dynamic braking

Specify CUTLER-HAMMER Custom-Built A-c Unbalanced Primary Control . . .

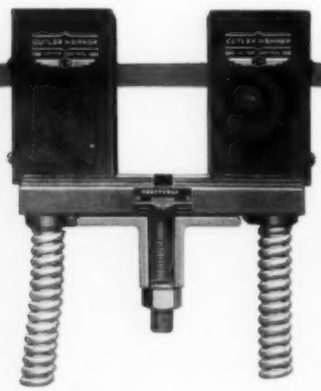
The Cutler-Hammer Unbalanced Primary Control permits a smoothly controllable reduction of speed and stable operation at any speed from standstill to synchronism . . . on slip ring wound rotor motors. This new yet fully tried and proved Cutler-Hammer control gives to alternating current motors, as for example on a draw bench, the same flexibility that could be gained otherwise only with direct current motors. Further information on this typical product of Cutler-Hammer specialization in motor control will be sent you on request . . . CUTLER-HAMMER, Inc., 1269 St. Paul Ave., Milwaukee 1, Wisconsin. *Associate:* Canadian Cutler-Hammer, Ltd., Toronto, Ont.

CUTLER-HAMMER
MOTOR CONTROL
C-H

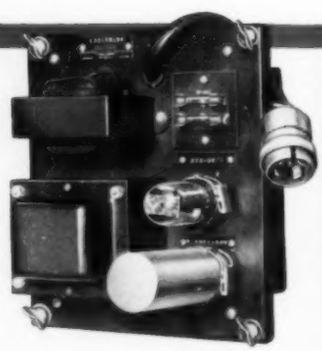
Typical Components of CUTLER-HAMMER Mill Control:



200 ampere heavy duty safety switch.

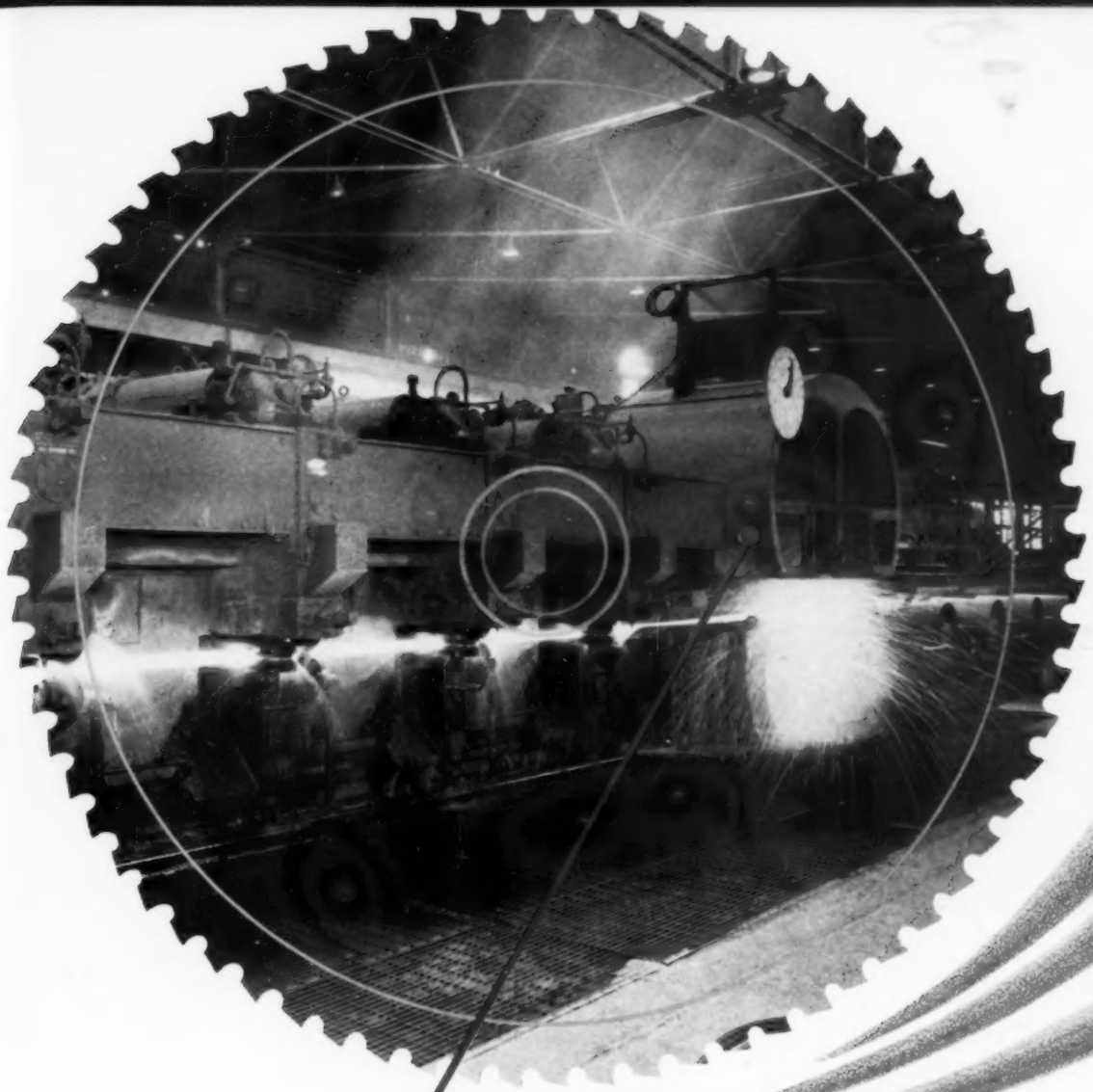


Magnetic limit switch.



Quick-change unit panel, photoelectric limit switch.

IRON AND STEEL ENGINEER, published monthly by Association of Iron and Steel Engineers, 1010 Empire Bldg , entered as second class matter January 25, 1924 at Pittsburgh, Pennsylvania, under Act of Congress March 3, 1879. $7.50 per year in United States and Canada, $10.00 foreign countries. Volume 26, No 8.



new HOT SAW cuts pipe 1,000 feet per minute

• **Aetna-Standard does it again!** The world's leading pipe mill designers and builders develop another idea to increase production in continuous butt weld pipe mills — A new Hot Saw that will cut off small diameter pipe at the rate of 1,000 feet per minute!

The new Aetna-Standard Hot Saw can operate at just twice the speed of hot saws now in use. And it cuts to allowable tolerances, too.

With the new Hot Saw, you can increase your production substantially.

Here's a sure way to reduce operating cost. Get the full story on the new Hot Saw from Aetna-Standard today.

THE AETNA-STANDARD ENGINEERING COMPANY
YOUNGSTOWN, OHIO
ASSOCIATED COMPANIES:
HEAD, WRIGHTSON & COMPANY, LTD., THORNABY-ON-TEES, ENGLAND
AETNA-STANDARD ENGINEERING COMPANY, LTD., TORONTO, ONTARIO, CANADA

IT'S
Q.C.*
THAT MAKES
National Rolls
BETTER

*QUALITY CONTROL at National has always been considered of the utmost importance in every step of production. From raw material analysis in the laboratory, extending through pouring and machining, careful attention is paid to every detail so that you are assured of flawless rolls that stand up on your stands for longer periods of time. Just try them and see.

NATIONAL ROLLS

THE NATIONAL ROLL & FOUNDRY CO.
AVONMORE, PENNSYLVANIA

SPECIALISTS IN IRON AND ALLOY IRON ROLLS

You'll Save . . .

You'll Get Faster Deliveries with *Pennsylvania*

STANDARD PARTS POWER TRANSFORMERS

Available in the following sizes:

Three Phase: Up to 10,000 Kva, 34 Kv
Single Phase: Up to 5,000 Kva, 34 Kv

This new line of Pennsylvania Power Transformers was designed to include the desirable features of custom-built transformers, at quantity production prices. Streamlined and standardized methods of manufacture, coupled with the use of standard designs and standard parts, shorten engineering and production time. This reduces the price of the transformer and shortens the delivery time.

Standard Parts Transformers can be supplied with any method of oil preservation.

Auxiliary tanks, welded to each end of the transformer and connected to each other and to the main tank, form the following oil preservation systems:

Inert Gas-Oil Seal

Sealed Tank

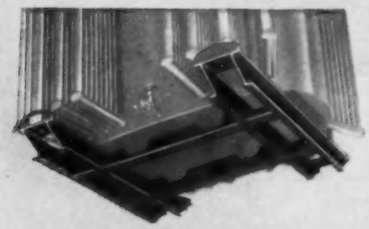
Inert Gas Pressure System

Oil expansion tank can be provided instead of auxiliary tanks.

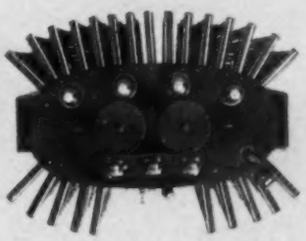
Auxiliary tanks, in most cases, do not add to the projected floor area.

The Sealed Tank and Inert Gas Pressure Systems can be changed, in the field, to Inert Gas-Oil Seal, without difficulty and without changing any parts. Inert Gas Pressure System can also be changed to Sealed Tank.

Transformers can be provided with Throats, and with Compartments for switchgear, etc.



Base for Standard Parts Transformer. Base is designed to simplify jacking, pulling, rolling, and painting.



Top of 4000 Kva Standard Parts Transformer. Note how auxiliary tanks fit into ends of the transformer and do not add to the length of the transformer.

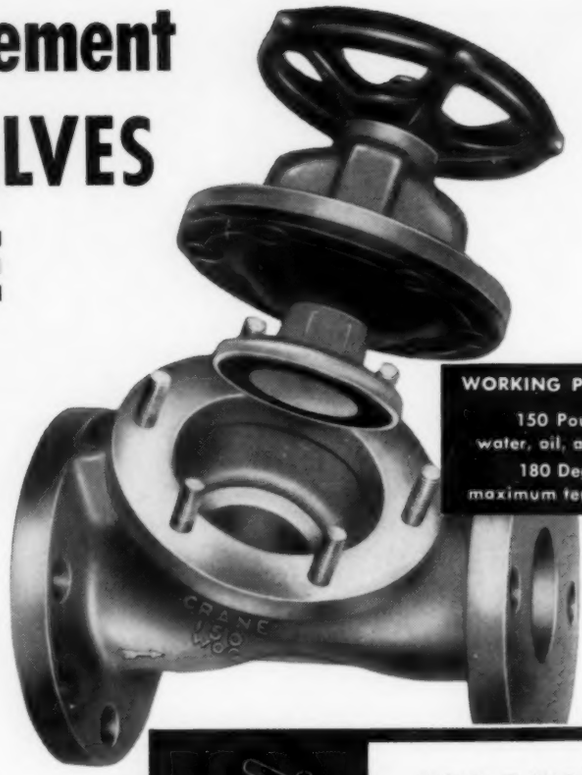
Standard Parts Power Transformer. 3750 Kva, 3 Phase, 60 Cycles, OA, 55°C. Voltage: 12,000 Delta-2,400 Delta/4,160 Y.

Pennsylvania TRANSFORMERS

For further information, write for Booklet No. 1492

Pennsylvania
TRANSFORMER COMPANY
PITTSBURGH 12, PENNSYLVANIA

outstanding improvement in DIAPHRAGM VALVES by CRANE



WORKING PRESSURE:
150 Pounds
water, oil, air or gas
180 Deg. F.
maximum temperature

NEW SEATING ARRANGEMENT MORE DURABLE... SAFER... MORE EFFICIENT

Now, after completing exhaustive tests, Crane presents this better diaphragm valve—better suited for more services under today's working conditions. Stemming from basic improvements, such as the radically new bonnet-sealing and valve-seating arrangement, this original Crane design introduces many outstanding service features like those shown here.

1. LONGER DIAPHRAGM LIFE, because diaphragm is used *only* to seal the bonnet—not for seating purposes.

2. POSITIVE SHUT-OFF in case of diaphragm failure. This is an exclusive Crane safety feature.

3. ACCURATE SEATING—new flat face disc with durable, resilient seating surface assures tight closure on all fluids.

4. GREATER FLOW CAPACITY with reduced resistance and pressure drop, assured by Crane Y-pattern body design.

5. EASIER OPERATION—Crane separate disc and diaphragm construction takes less torque—fewer turns—to operate.

HOW IT WORKS

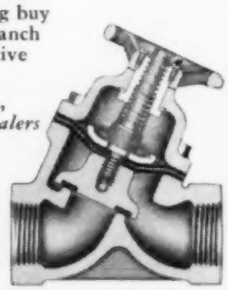
The Crane diaphragm serves one function only—sealing the bonnet. It is not subject to crushing and rapid wear. The seating member is a separate circular flat face disc, firmly attached to the stem and joined to the diaphragm with a special leakproof connection. This independent seating feature permits positive shut-off with no loss of fluid, even in case of diaphragm failure.

GET THIS DESCRIPTIVE CATALOG

See these new valves—the outstanding buy in their class—at your local Crane Branch or Wholesaler. Or write for descriptive catalog AD-1761.

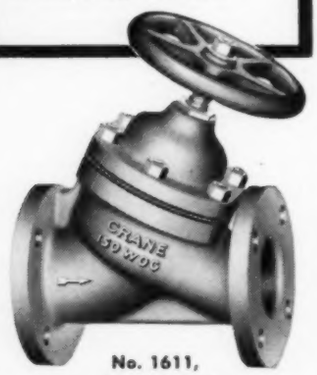
CRANE CO., 836 S. Michigan Ave., Chicago 5, Ill. *Branches and Wholesalers Serving All Industrial Areas.*

This new Crane line includes iron valves with screwed ends in sizes ½ to 2 in.; with flanged ends from ½ to 4 in. Neoprene coated valves —flanged ends only—in sizes from ½ to 4 in.



No. 1610, screwed ends

No. 1615, flanged ends, neoprene coated



No. 1611, flanged ends

EVERYTHING FROM . . .

VALVES
FITTINGS
PIPE

CRANE

PLUMBING
AND
HEATING

FOR EVERY PIPING SYSTEM

A PRETTY THIN STORY

We're speaking of rolling aluminum. The thinner you roll it, the further it goes, the wider your market possibilities.

Morgoil Roll Neck Bearings have proved to be a mighty important factor in rolling aluminum thin. Some mills are rolling it down to .00025" at a very fast clip. This requires the accuracy and precision found *only* in Morgoils.

Now let us tell you about the new Ball Thrust Morgoil for bearings 18" and less, being used on both new and old mills. Write today

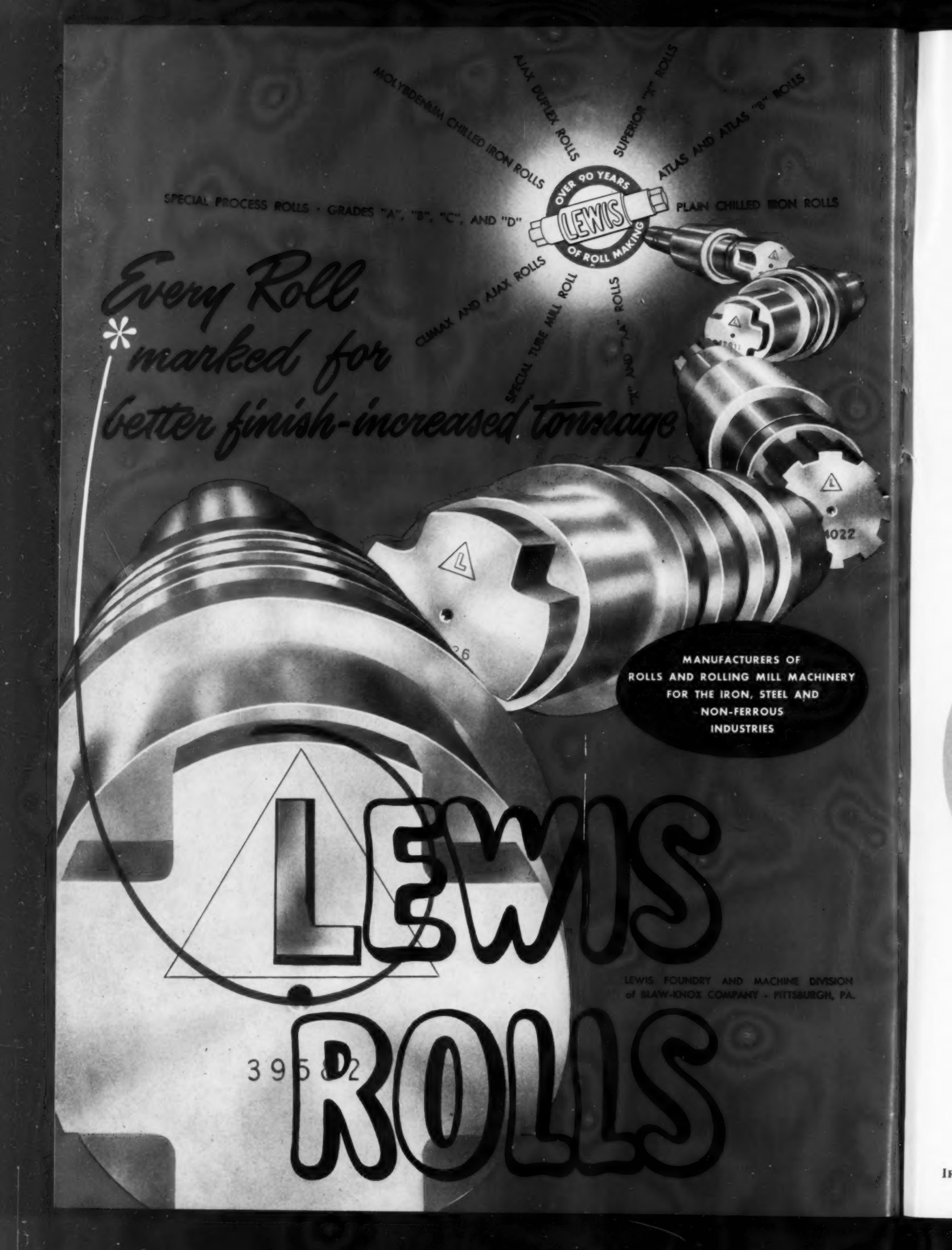
MORGAN CONSTRUCTION CO.
WORCESTER, MASSACHUSETTS

English Representative
International Construction Co.
56 Kingsway, London, W. C. 2, England

MB-11

MORGAN
WORCESTER
ROLLING MILLS · MORGOIL BEARINGS
WIRE MILLS - GAS PRODUCERS - AIR EJECTORS
REGENERATIVE FURNACE CONTROL

MORGOIL
ROLL NECK BEARINGS


MOLYBDENUM CHILLED IRON ROLLS
AJAX DUPLEX ROLLS
SUPERIOR "F" ROLLS
ATLAS AND ATLAS "B" ROLLS
SPECIAL PROCESS ROLLS · GRADES "A", "B", "C", AND "D"
OVER 90 YEARS
LEWIS
OF ROLL MAKING
PLAIN CHILLED IRON ROLLS
CLIMAX AND AJAX ROLLS
SPECIAL TUBE MILL ROLL
"A" AND "AA" ROLLS
Every Roll
*marked for
better finish-increased tonnage
4022
MANUFACTURERS OF
ROLLS AND ROLLING MILL MACHINERY
FOR THE IRON, STEEL AND
NON-FERROUS
INDUSTRIES
LEWIS
ROLLS
LEWIS FOUNDRY AND MACHINE DIVISION
of BLAW-KNOX COMPANY - PITTSBURGH, PA.

YOU CAN BE **SURE**.. IF IT'S

Westinghouse

CONTROLLED ACCURACY

with the NEW WESTINGHOUSE X-RAY THICKNESS GAUGE

A look at the remote control panel pictured above shows at a glance the advantages of the Westinghouse X-Ray Gauge over other methods of thickness gauging.

1. Controls may be set to operate tolerance limit indicator lights for high-speed mill applications or to operate the reject gate on a classification line.
2. Gauge can be calibrated from operator's control panel.
3. Comparison standards permanently mounted in lower arm of gauge are set up automatically to thickness chosen on control panel. No manual handling of calibration samples.

Here's how to gauge the steel strip on high-speed, cold reduction mills or the slower classification line. The Westinghouse X-Ray Thickness Gauge provides a direct comparison method of gauging accuracy which is independent of strip speed and yet holds to minute tolerances. There is no contact between gauge and sheet . . . no damage to strip surface . . . no mechanical gauging wheels to maintain.

What's more, operation and calibration of the gauge are handled by remote control at the operator's control panel.

The gauge employs two x-ray tubes and one photo-multiplier tube, resulting in complete circuit stability. It is compact, of rugged mechanical construction and experience-designed to give "steel-mill" type continuity of service.

Here are other advantages:

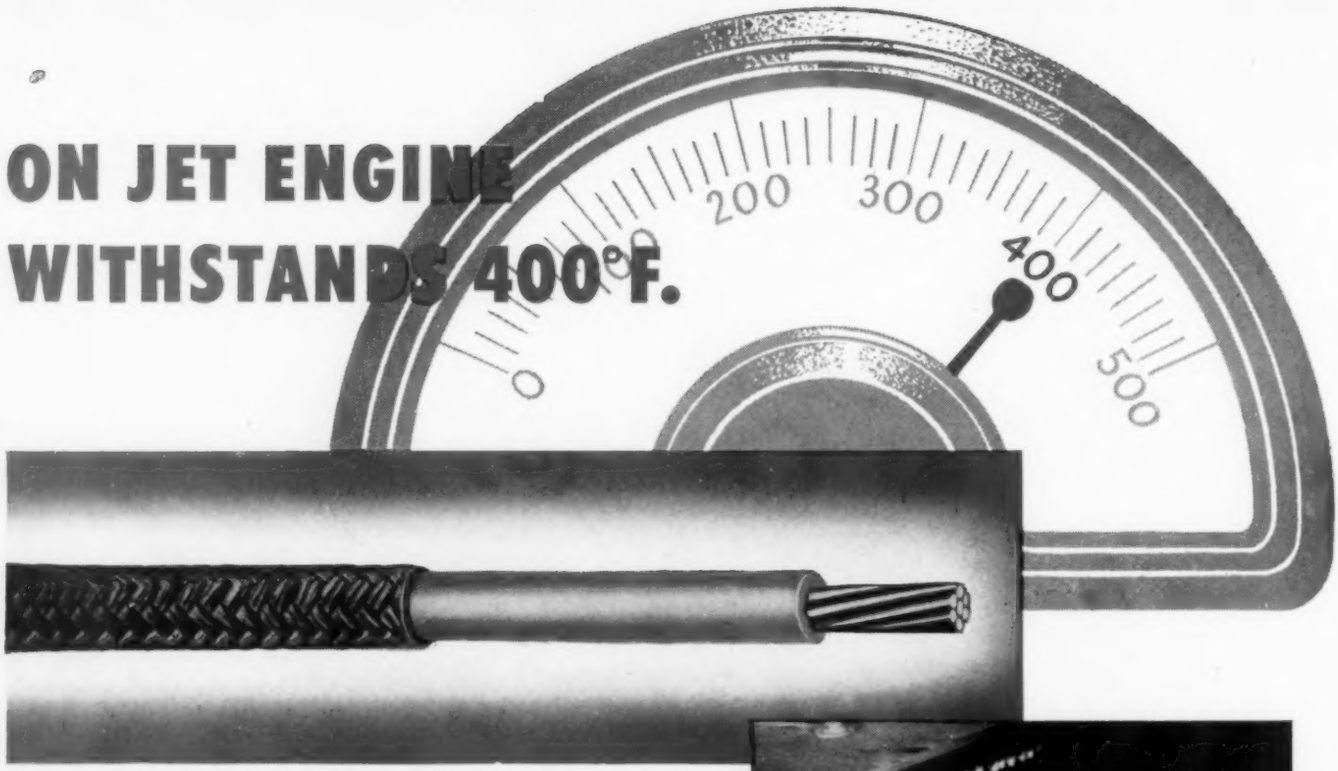
- Rapid setup time for each run
- Wide throat for easy threading of strip
- Arms in suitable lengths for specific requirements
- Unit may be installed to allow lateral scanning of strip

All in all, the new Westinghouse X-Ray Thickness Gauge is the direct route to economy for you and quality for your customers. Get the facts today. Call your local Westinghouse representative, or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pa. J-08223

Westinghouse

X-RAY

ON JET ENGINE WITHSTANDS 400° F.



Okotherm cables for high temperature service can be made in a wide range of sizes and types, using glass, asbestos or other protective coverings.

THE REMARKABLE heat-resisting quality of Okotherm insulated cables has been highlighted by their adoption in a jet engine that develops temperatures as high as 400° F. As a result of intensive investigations by Okonite researchers of heat-resisting materials, it was found that ignition wire insulated with Okotherm would fulfill the requirements. Consequently it became the first to gain approval for the new engine.

Compounded with silicone, Okotherm insulation retains its dielectric strength after long-time exposure to high temperatures as well as those as low as —65° F. Okotherm insulation helps wiring withstand outdoor weathering without deterioration—keeping flexible at all operating temperatures, resisting oxidation and ozone.

In addition to high voltage ignition, cables with Okotherm insulation should be considered for electric ovens, furnaces and motors, high-intensity floodlights, street lights and neon signs—wherever excessive heat must be encountered.

Oven and freezing tests show that Okotherm insulation retains its properties over a wide temperature range where ordinary insulations fail due to loss of elastic properties or thermal instability.

If you should have no immediate use for heat-resisting Okotherm, some other special-purpose Okonite cable may fit your needs. "Unusual" cable installations have a way of turning out to be Okonite. Problem solving is our business. Why not talk over your cable problem with an Okonite engineer? The Okonite Company, Passaic, New Jersey.

THE BEST CABLE IS YOUR BEST POLICY

7119

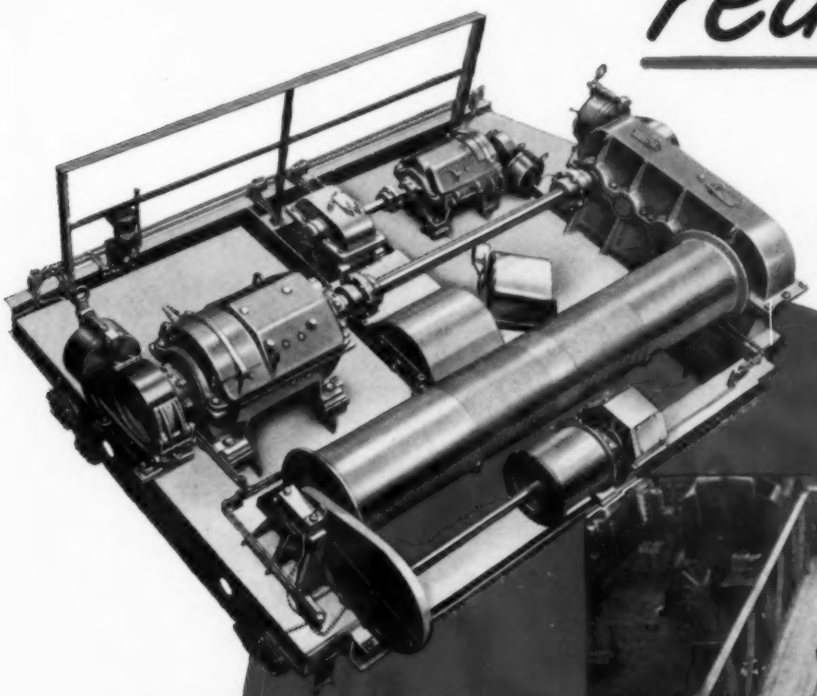
OKONITE OKONITE SINCE 1878 ***insulated wires and cables***

P&H MILL TYPE CRANES

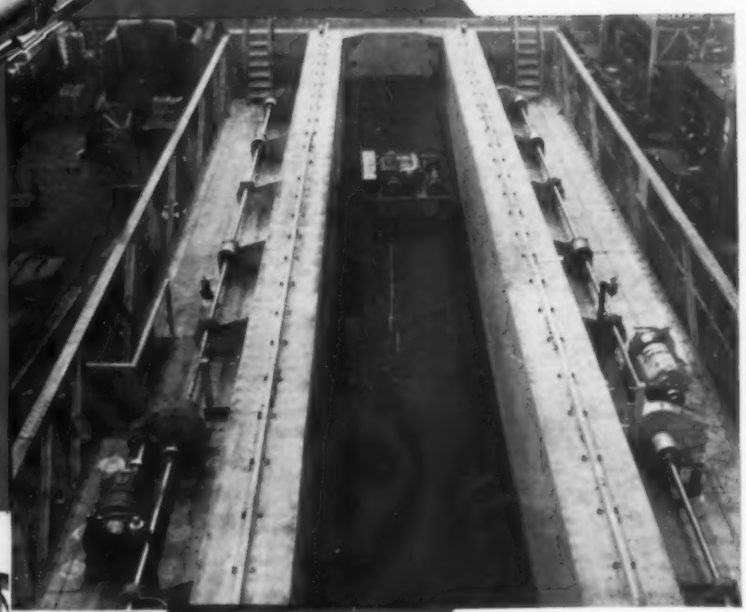
redesigned

to meet new

I.&S.E. specifications



Enclosed gearing throughout, including drum gear. All gears run in oil bath; no more dripping grease. Head sheaves accessible above trolley deck.



Three gear case bridge drive with all gears running in oil bath.

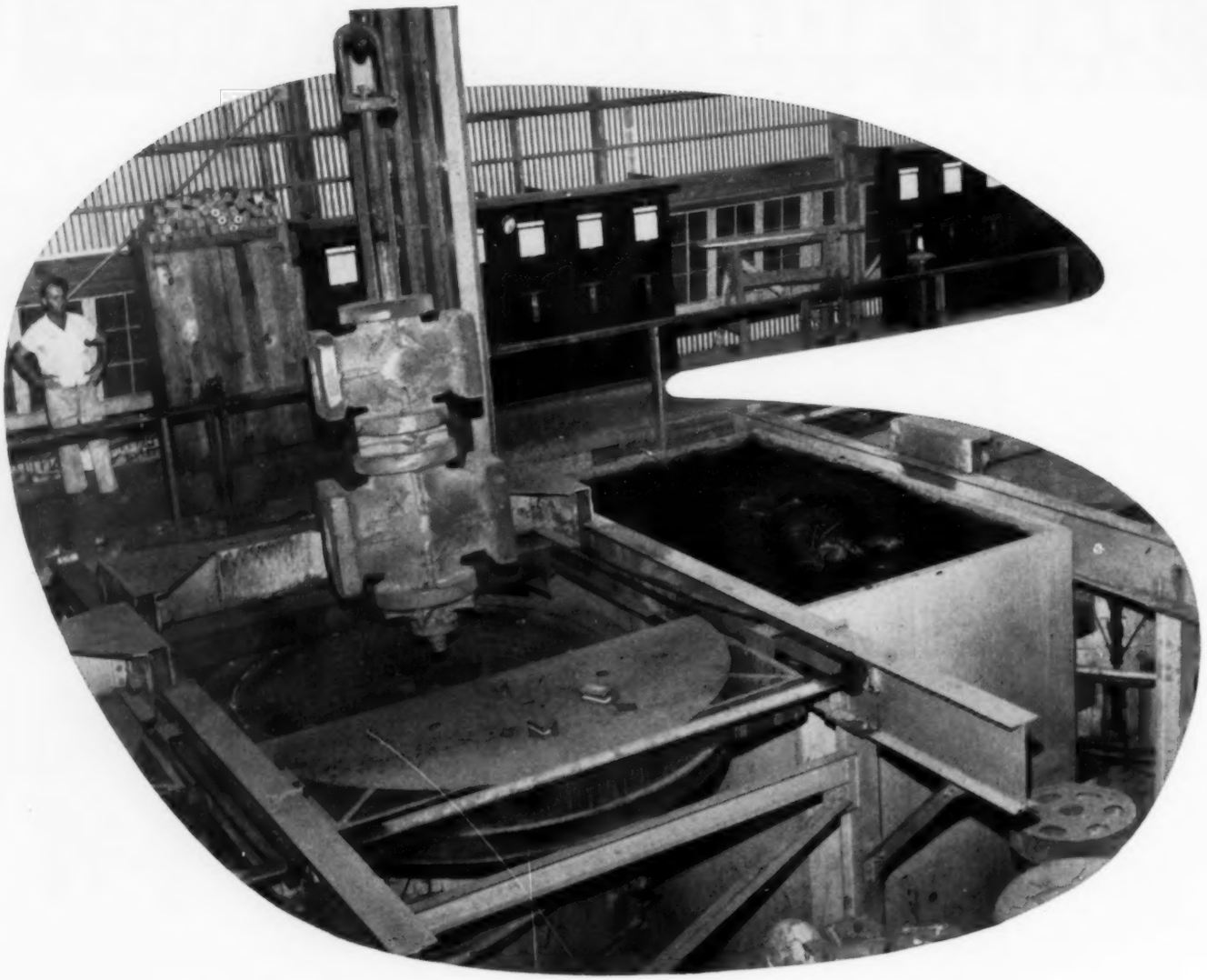
And a multitude of other advanced mill design features you will want to know about. Write for information.

P&H

MILL TYPE CRANES
4455 W. National Avenue
Milwaukee 14, Wisconsin

HARNISCHFEGER
CORPORATION
ELECTRIC CRANES • EXCAVATORS • ARC WELDERS P&H HOISTS • WELDING ELECTRODES • MOTORS

AMERICA'S LEADING BUILDER OF OVERHEAD ELECTRIC CRANES



a real "treat" for metals

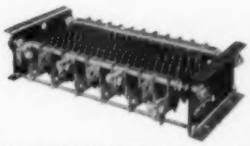
High quality heat-treating is nothing new at Texas Electric Steel Casting Co. Tesco has specialized along these lines for over 20 years. And they've found they can rely on Micromax automatic control to back them up . . . every time . . . even when they guarantee to hold temperature to a ±10 F tolerance! Micromax *dependability* is especially valuable in 24-hour, 7-day-a-week operation. Its micro-responsive control holds heating, soaking, and cooling temperatures without a break. Its automatic standardizing protects accuracy, while its anticipating action offsets the effects of changes in outside temperature and other "weather" conditions. Such smoother performance is available for all furnaces—car-bottom and vertical, such as Tesco's . . . continuous furnaces . . . controlled atmosphere installations; and for practically *any* product where uniformity and *economy* are important. For a "treat" which will enable your products to make new friends, investigate Micromax. Write Leeds & Northrup Co., 4942 Stenton Ave., Philadelphia 44, Pennsylvania.

MEASURING INSTRUMENTS · TELEMETERS · AUTOMATIC CONTROLS · HEAT-TREATING FURNACES

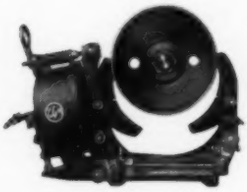
LEEDS & NORTHRUP CO.

Jrl Ad ND44-33-620(2)

Complete Control for Cranes



TAB - WELD Resistors — no burning where burning would cause high up-keep.



LONG-LIFE Brakes give high speed performance—with low up-keep.

SHORT - THROW, Narrow Width Cam Type Master Switches are easy on the operator.

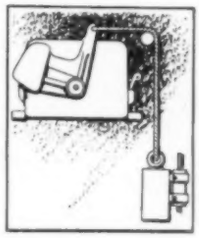
REVERSING-PLUGGING Control for bridge and trolley motions. Only one adjustable plugging relay.

Increased Output
And Greater Protection
On A-C and D-C Cranes with . . .

EC&M YOUNGSTOWN SAFETY LIMIT STOP

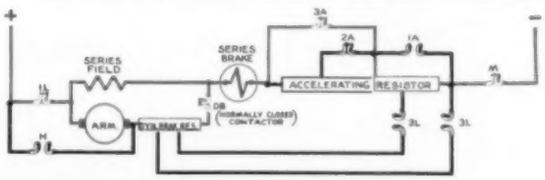
1. Enables the operator to do better work, because the fear of an overhoisting accident is removed.
2. Raises "working-ceiling" of area served by crane, because hook stops quickly when the limit stop trips.
3. Re-sets automatically—hook lowers out of the danger zone the instant the hoist-controller in the cab is reversed. Transfer from "tripped" to "normal" connections is rapid. Small travel between these two positions.
4. Stretching of the hoisting cables does not affect the tripping-point—the Limit Stop is operated directly by the hook block.
5. Compact, easy to mount—and only a single suspended weight.
6. Disconnects hoist-motor from the line—high interrupting capacity insures positive opening of the hoist motor current.

Specify BULLETIN 1032 YOUNGSTOWN Safety Limit Stops when buying cranes.



Optional off-set weighted-arm eliminates intermediate sheaves—speeds installation and reduces cable bends.

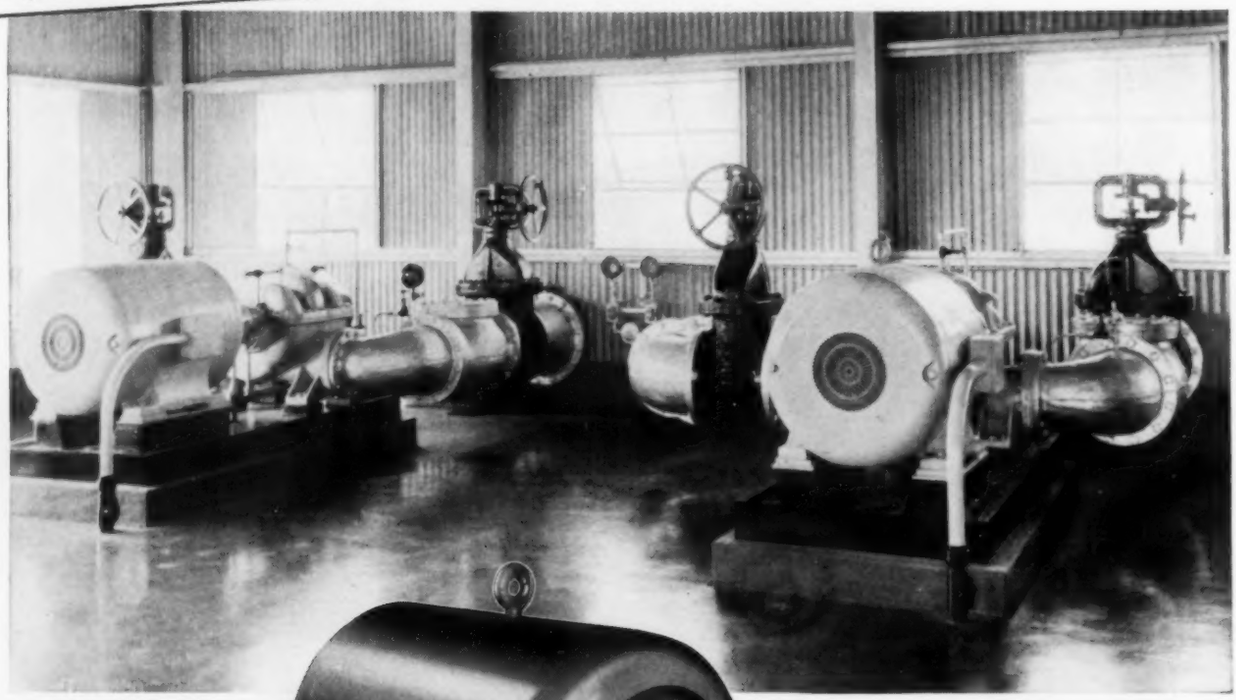
SIMPLIFIED, Safe, Dynamic Lowering Hoist Control



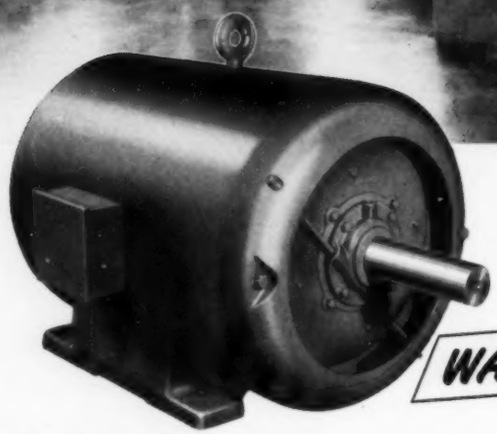
CRANE DISCONNECT SWITCH Manual-Magnetic Type

THE ELECTRIC CONTROLLER & MFG. CO.
2698 East 79th Street • Cleveland 4, Ohio

Pretty... but oh so TOUGH!



Wagner 100 hp totally-enclosed, fan-cooled motors driving water circulating pumps at a Texas refinery.



WAGNER CP MOTORS

Don't let their neatness fool you. These 100 hp Wagner totally-enclosed, fan-cooled motors do a giant-sized job—driving water circulating pumps at a Texas refinery.

Motors that drive pumps and compressors find the going tough. They must overcome back pressures set up by fluids or gases—they are often required to make repeated starts and stops—they are sometimes kept in continuous service.

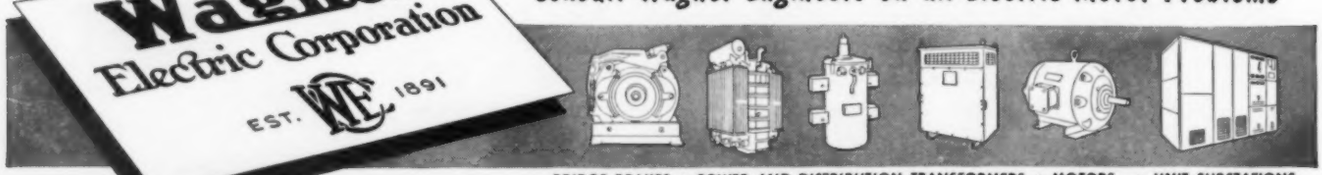
But Wagner Motors can take it. There is a Wagner Motor correctly engineered to meet the requirements of every type of pump or compressor. You can choose the motor to fit your need from the wide variety of types and sizes in the Wagner line. Bulletin MU-185 gives full details.

Buyers of Wagner Motors get Nationwide Service! More than 450 Wagner Authorized Electrical Service Stations and Parts Distributors *plus* 25 Wagner-owned Service Branches are ready to immediately supply on-the-spot service, factory guaranteed exchange motors, or genuine Wagner parts. Write for Bulletin MU-24 for complete list.

Wagner Electric Corporation

6483 PLYMOUTH AVE., ST. LOUIS 14, MO., U. S. A.

Consult Wagner Engineers on all Electric Motor Problems

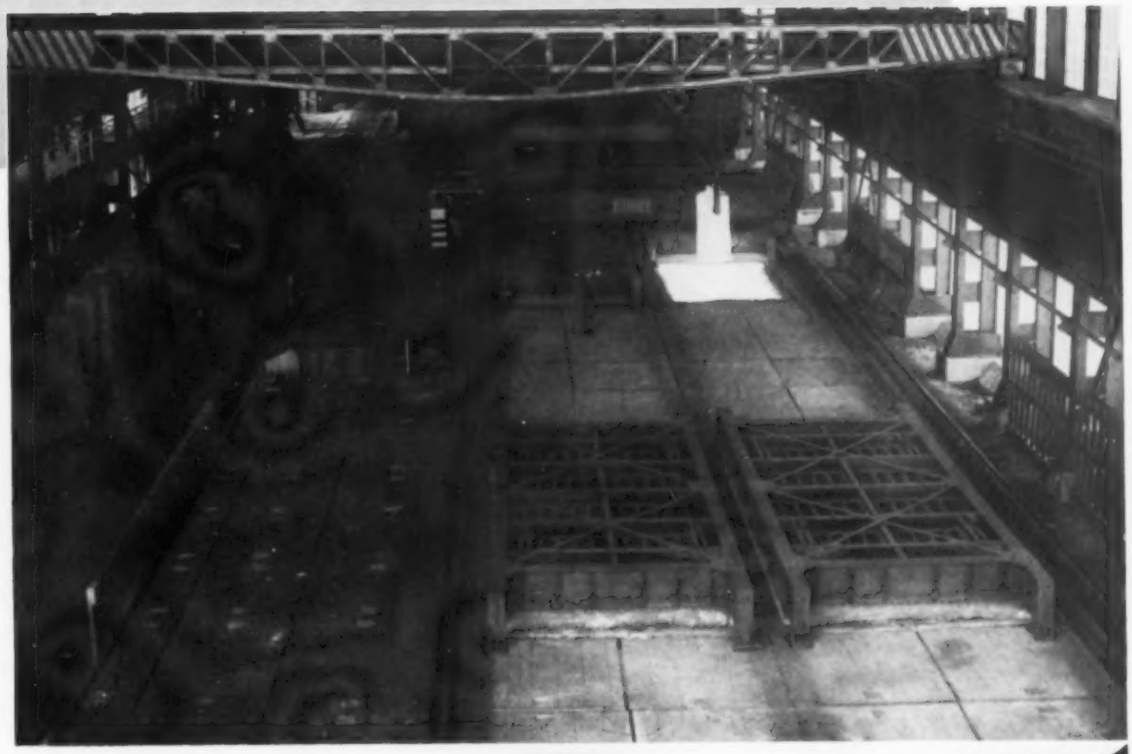


BRIDGE BRAKES • POWER AND DISTRIBUTION TRANSFORMERS • MOTORS • UNIT SUBSTATIONS

ELECTRICAL EQUIPMENT AND AUTOMOTIVE BRAKE PRODUCTS

M49-17

FOR IMPROVED INGOT HEATING



F.E.I. SOAKING PITS

The new style regenerative soaking pits designed by Furnace Engineers, Inc., will increase your output of heated ingots and substantially lower your fuel and maintenance costs. Fired by a mixture of cold and clean blast furnace gas enriched with coke oven gas, the soaking pits provide higher temperatures in the preheated air.

F.E.I.'s new regenerative soaking pits include all the latest improvements: most modern instrumentation, double-pass checkers, Isley controls, flat door arches and flat checker arches. They operate with the utmost efficiency and dependability.

An F.E.I. representative will be glad to provide you with full details at your convenience. Write or call today.

U.S PATENTS—2,446,642; 2 403,431; 1,913,170.
OTHER PATENTS PENDING.

FURNACE ENGINEERS, INC.

1552 W. Liberty Ave., Pittsburgh 26, Pa.

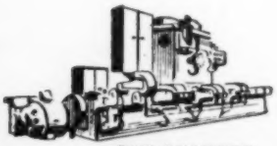
Still more Bonnot Billeteers are on the way to Europe to join those already speeding steel production for industrial recovery. Plants receiving the new Billeteers in the near future are located in Belgium, Luxemburg, Italy and France.

World-wide acclaim for the Billeteer lies in what the Billeteer is doing for every plant in which it is installed. The billet shed was once the bottleneck between furnaces and shipping docks. Today with Bonnot Billeteers, deep flaws can be cut out and remelting of billets is practically eliminated—there's a steady flow of clean billets to finishing mills. Operating records show a Billeteer handling 100 tons of billets per shift—removing up to 1½ tons of steel scrap—all flaws completely eliminated—all chips 100% reclaimable.

Just one operator handles the Billeteers easily during an 8-hour shift, doing the work of more than 10 hand chippers and without the fatigue and manpower turnover that results from more muscular methods of billet cleaning. Why not let the Bonnot Billeteer work for you? Write for information today!

Engineered for Improved Production

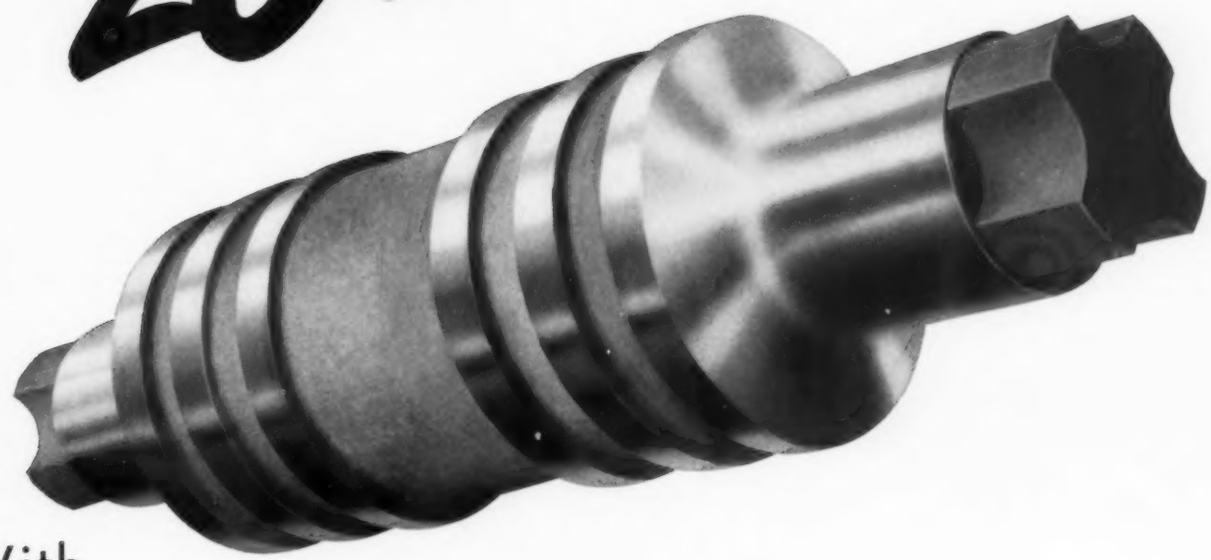
The Bonnot Co.
STEEL EQUIPMENT DIVISION
CANTON 2, OHIO



THE BILLETEER

ALSO MANUFACTURERS OF SAWING · CRUSHING · PULVERIZING & MIXING EQUIPMENT
BILLET INSPECTION TABLES · DUST PUG MILLS · SINTER PLANT PUG MILLS

"20% MORE TONNAGE"



With

"BIRDSBORO 40" COPPER ALLOY STEEL ROLLS

and we quote!

(from a letter received from one of our customers)

"In rolling alloy, stainless and high-speed steels, roughing and intermediate rolls are not only subject to a great deal of sudden shock but, at times, are run as much as eight hours without 'water cooling.'

"By using 'Birdsboro 40' Rolls, we have been able to increase the carbon range from 1.05/1.15 to 1.20/1.30, have little or no fire-cracking and still have a stronger roll than any other alloy steel roll of the same carbon range.

"Our overall tonnage per hour has increased over 20% in the past three years, yet our roll breakage has decreased and we now have more 'Birdsboro 40' Rolls going down to scrap diameter, without breaking, than any other rolls we have used."

• These are copper-alloy steel rolls to which extensive research and long roll-making experience have contributed to long roll life, as well as top performance, which insures high production at low cost.

R-5

Offices in:
BIRDSBORO, PA. & PITTSBURGH, PA.

Representative:
332 So. Michigan Ave.
Chicago 4, Illinois

Birdsboro Steel Foundry & Machine Co. • Birdsboro, Pa.

BIRDSBORO
ROLLS

DESIGNERS and BUILDERS OF: Rolls • Crushing Machinery • Steel Mill Machinery • Hydraulic Presses • Steel Castings • Special Machinery

UNION BUILDS IT *YOUR* WAY!

"UNION" Makes Better:

Ingot Cars

Peels

Blast Furnace Bells

Charging Boxes

Charging Box Cars
ANNEALING BOXES AND COVERS
SLAG POT CARS
SOAKING PIT COVERS
LOCOMOTIVE FRAMES... WHEEL CENTERS
"UNIVAN" VANADIUM STEEL CASTINGS

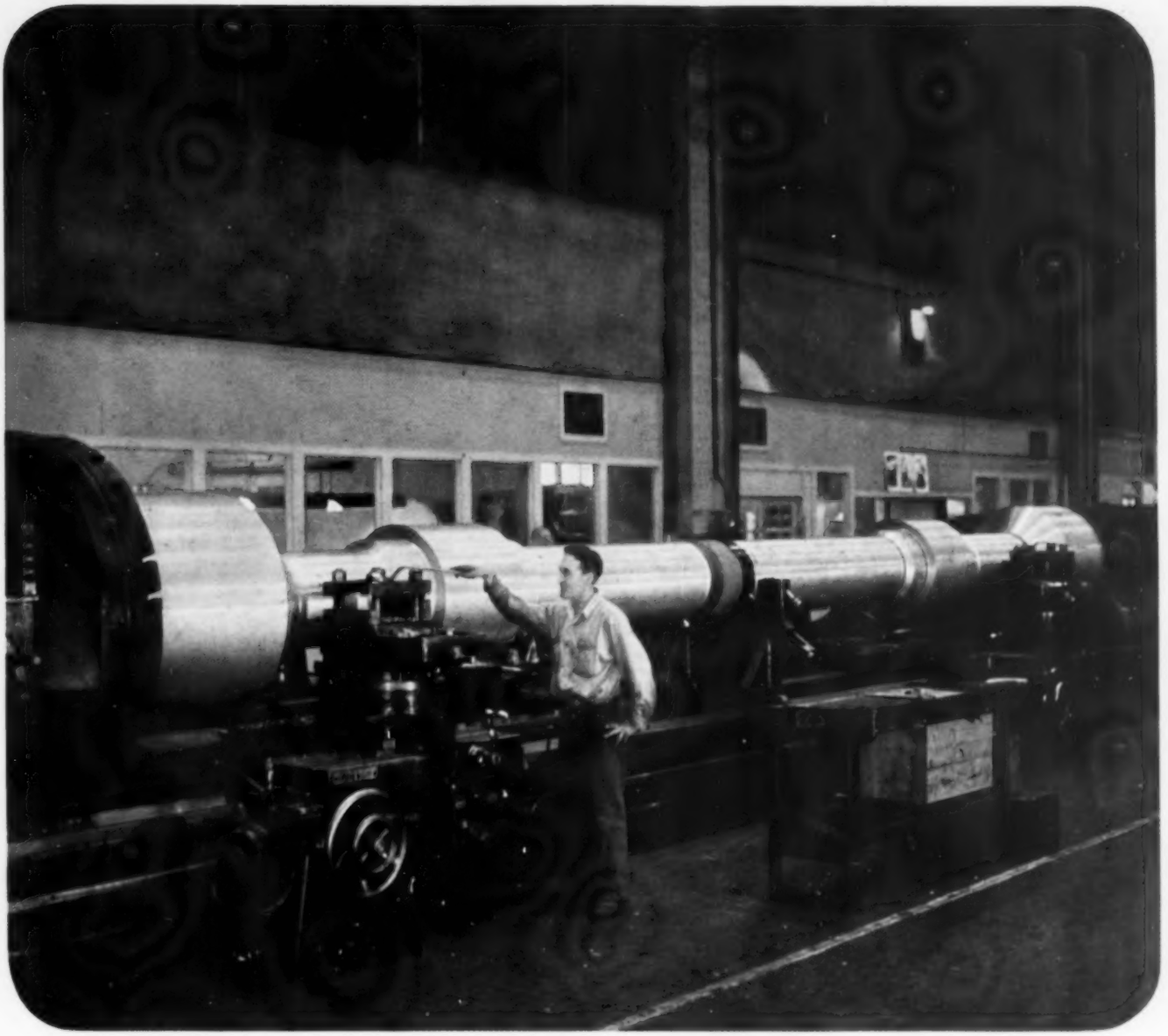
BRING YOUR SPECS TO UNION

Nobody knows better than yourself what features you want in your ingot and charging box cars. Whatever they are, the entire facilities of our Engineering Department, Foundry and complete Machine Shop exist for only one purpose — to take your specifications and develop, produce and deliver a car to meet your requirements; one that will give you the trouble-free economical service you've learned to expect from Union Steel products.

Cast in one piece, these cars are rigid and rugged; can take it when subjected to the banging around encountered in open hearth service and will stay on the job trip after trip to bring your "cost per mile" down. Write for facts and figures.

UNION STEEL CASTINGS

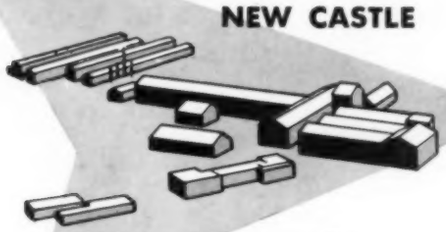
DIVISION OF BLAW-KNOX COMPANY . . . PITTSBURGH 22, PA.

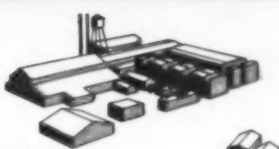


Turning 33" Blooming Mill Spindle, New Castle, Pa. plant

Plants at

NEW CASTLE



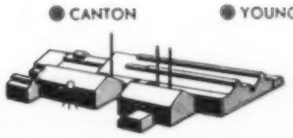


● PITTSBURGH

● VANDERGRIFT

● AKRON

● CANTON



● YOUNGSTOWN

UNITED ENGINEERING AND FOUNDRY COMPANY

PITTSBURGH, PENNSYLVANIA

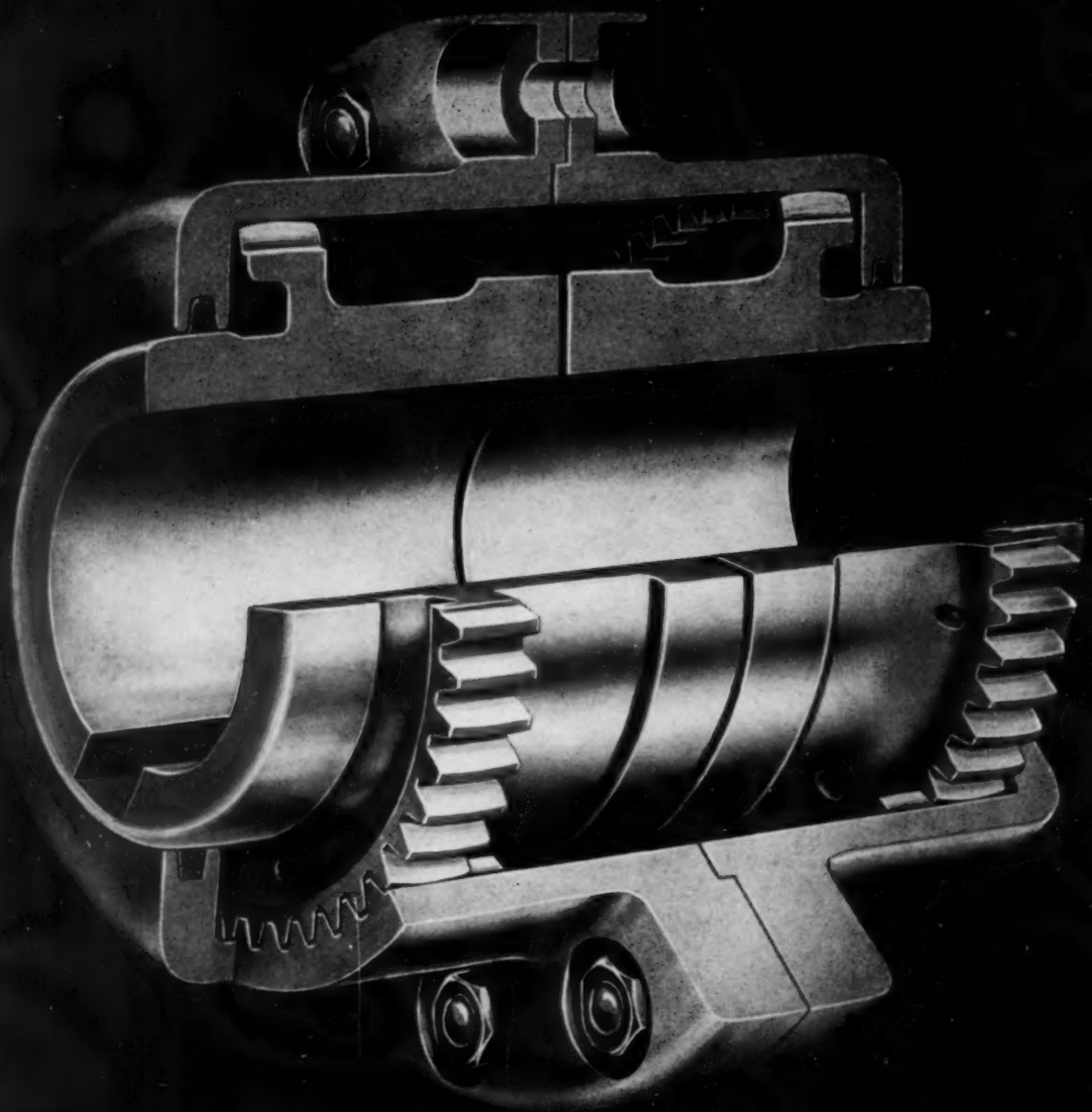
Subsidiary: Adamson United Company, Akron, Ohio.

Affiliates: Davy and United Engineering Company, Ltd., Sheffield, England;
Dominion Engineering Works, Ltd., Montreal P.Q. Canada;
S. E. C. I. M., Paris, France

Designers and Makers of Rolls and Rolling Mill Equipment

REG. T. M.

POOLE



A COPY OF CATALOG GIVING FULL DESCRIPTION AND ENGINEERING DATA SENT UPON REQUEST.

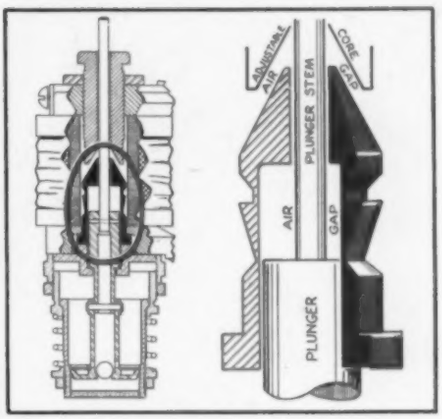
FLEXIBLE COUPLINGS

POOLE FOUNDRY & MACHINE COMPANY

WOODBERRY, BALTIMORE, MD.

Complete MOTOR PROTECTION Under All Conditions with these EC&M Overload Relays

Instantaneous Trip; also Time-Delay Operation for Single Phase, Failure to Start, Running, Etc. — all in this one Relay.



Special Iron Sleeve with tapered wall thickness provides magnetic balance, permitting *low* current setting.

EC&M Type ZM Overload Relays for use in A-c Starters are of the magnetic type. They trip *instantly* on heavy overloads or short circuits and provide *inverse-time-element* trip on prolonged overloads or if the motor fails to start.

A *low* current-setting for accurate protection under running conditions is possible with these Relays because a magnetic-balance in each relay permits the absorption of the heavy inrush currents while the motor is accelerating. When the current is normal, the relay drops back automatically to keep timing at the maximum.

On short circuits the time-delay feature is by-passed. A spring on the outside of the dashpot-case normally holds the dashpot down, allowing the plunger to pull through the silicone fluid. When an excessive current occurs, the dashpot and plunger lift as a unit—the outer spring on the dashpot being compressed as the plunger *instantly* rises to trip the relay-contacts without delay.

Complete description of these Relays is given in Bulletin 1180-2 and No. 19 ACCELERATOR. Write for your copies.

These EC&M Push Button Motor Starters are regularly supplied with these accurate relays.

VALIMITOR Starters — 2300-4600 Volt Motors

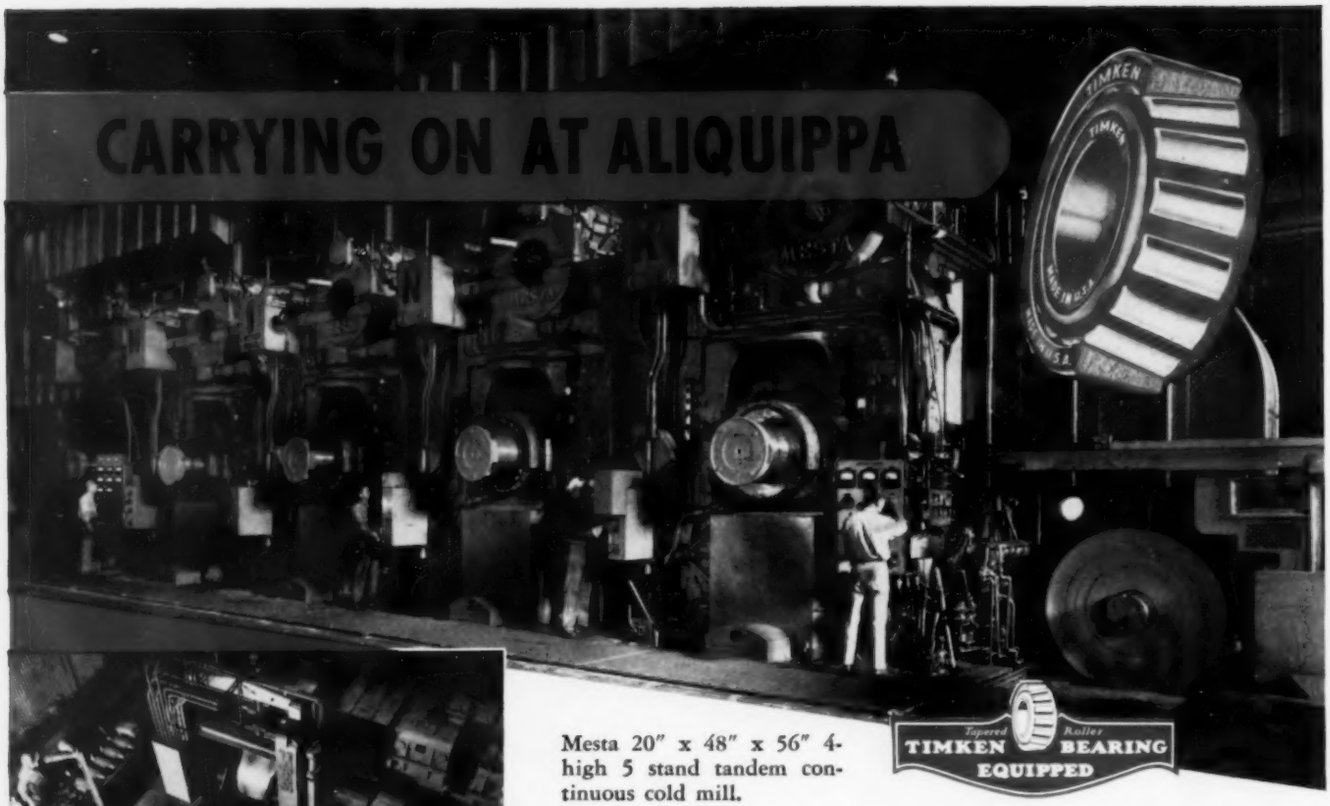
2300 V. Reduced Voltage Starter

220-550 V. Reduced Voltage Starter

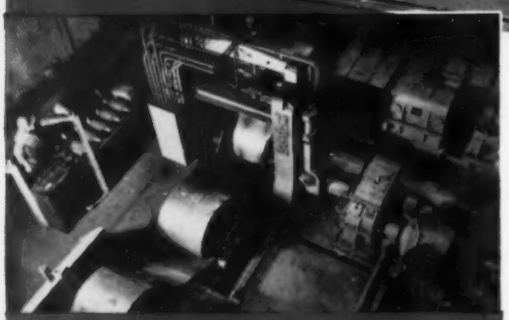
THE ELECTRIC CONTROLLER & MFG. CO.

2698 EAST 79th STREET • CLEVELAND 4, OHIO

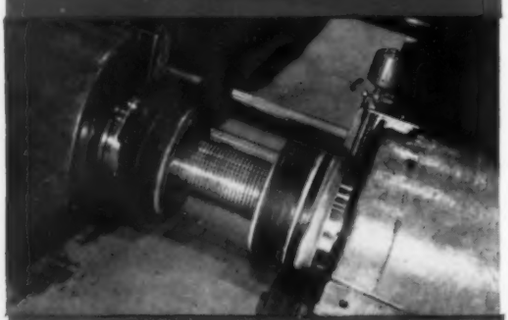
CARRYING ON AT ALIQUIPPA



Mesta 20" x 48" x 56" 4-high 5 stand tandem continuous cold mill.



McKay processing uncoiler.



Mesta slitter.

Seamless tube mill thrust block.

Through the years more Timken tapered roller bearings have gone into service in major equipment in American steel mills than any other anti-friction bearings.

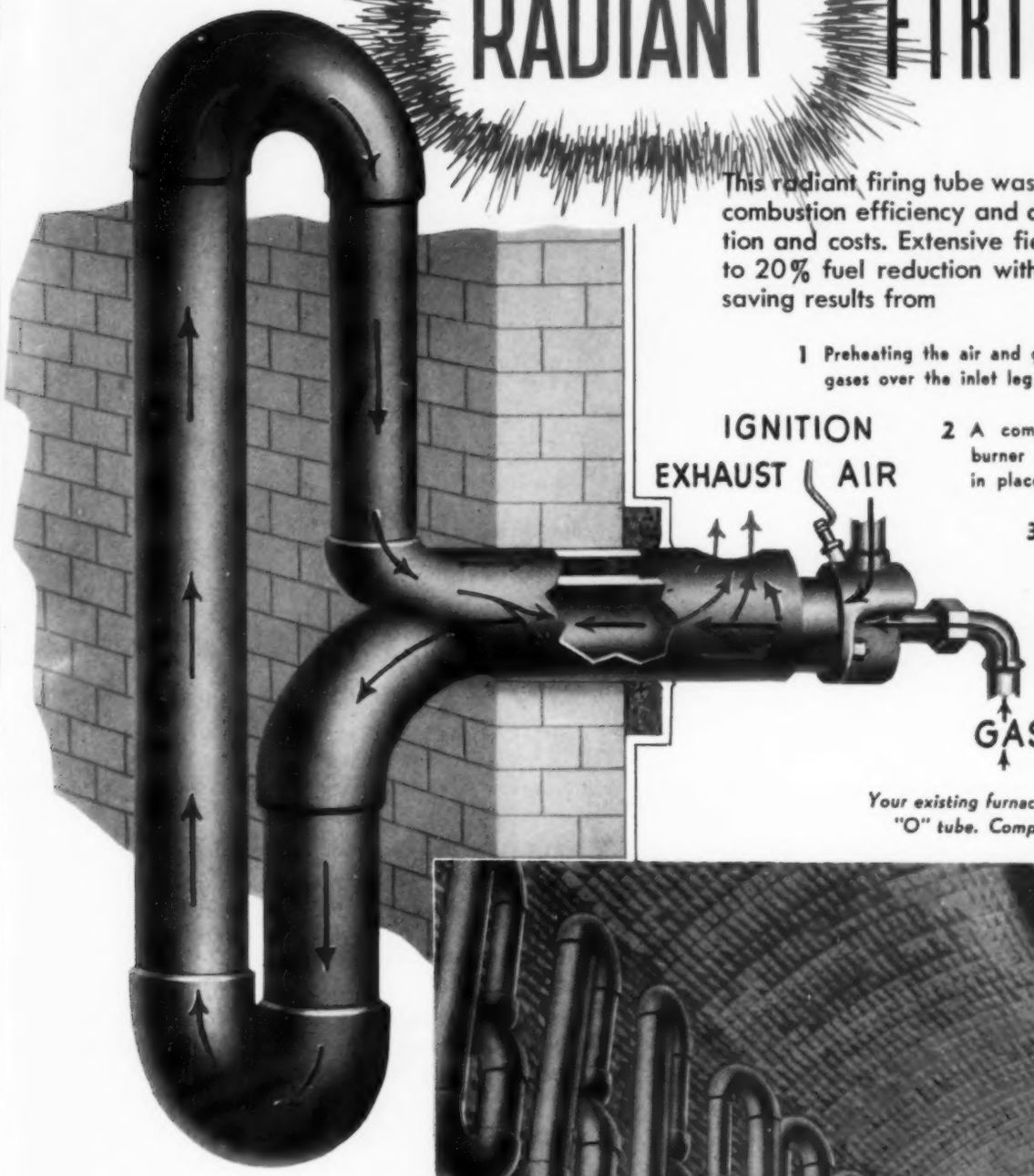
Since the days when anti-friction bearings were first installed in rolling mills (they are generally credited with making the four-high continuous high-speed mill possible) Timken bearings have rolled up an unsurpassed record of performance and economy on mill roll necks.

Some of the important equipment at the Aliquippa, Pa. works of Jones & Laughlin Steel Corporation using Timken bearings is shown in the photographs. Timken bearings also are used in a lot of other miscellaneous equipment at the Aliquippa plant, including mill drives, edger drive, coil holders, levelers, table rolls, trailers, shears, straightening machines, reels, hot metal cars, tube sizing mill, roll lathe, quenching car, cranes, temper passwork rolls, scrubbers, ingot strippers, trimmers and shop trucks. The Timken Roller Bearing Company, Canton 6, Ohio. Cable address "TIMROSCO".

TIMKEN
TRADE-MARK REG. U. S. PAT. OFF.
TAPERED ROLLER BEARINGS

NOT JUST A BALL ○ NOT JUST A ROLLER ⬭ THE TIMKEN TAPERED ROLLER ⬭ BEARING TAKES RADIAL ⊕ AND THRUST →⊕← LOADS OR ANY COMBINATION →✳←

Lee Wilson ANNOUNCES THE "O" TYPE RADIANT FIRING TUBE



This radiant firing tube was developed to increase combustion efficiency and decrease fuel consumption and costs. Extensive field tests indicate a 15 to 20% fuel reduction with longer tube life. This saving results from

1 Preheating the air and gas by passing the exhaust gases over the inlet leg of the tube.

2 A complete tight furnace at the burner mounting—tubes are welded in place.

3 The use of the Lee Wilson dual pressure burner, with primary and secondary air adjustment, which can increase heat release at bottom of tube to apply radiant energy most effectively.

Your existing furnaces can be converted to use the "O" tube. Complete information on request.

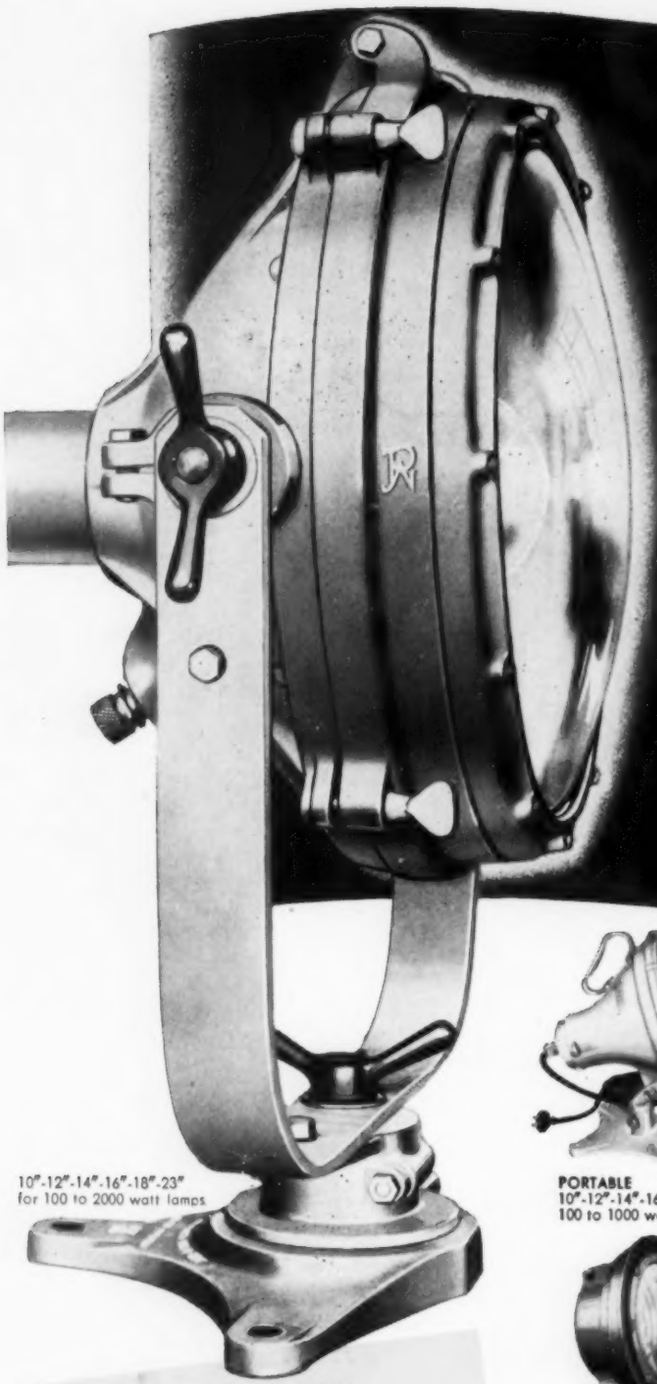
This picture shows interior of a furnace fitted with 36 "O" tubes. This unit must be completely gas tight for carbon restoration application.

Lee Wilson ENGINEERING Co., Inc.

20005 WEST LAKE ROAD • CLEVELAND, OHIO

Telephone ACademy 4670

INDUSTRIAL FURNACES • RADIANT TUBE HEATING • HEAT TREATING PROCESSES



10"-12"-14"-16"-18"-23"
for 100 to 2000 watt lamps

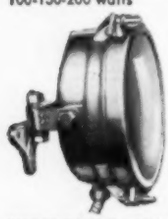
Specify— PYLE-NATIONAL FLOODLIGHTS

for Permanent Heavy-Duty Floodlighting

Dependable Floodlighting with Minimum Maintenance

PORTABLE
10"-12"-14"-16"
100 to 1000 watts

FLUSH—10" for Pit or Subway Wall or Ceiling
100-150-200 watts



SHORT RANGE—10"-12"
for Wall Mounting
100-150-200 watts

Pyle-National floodlight equipment is designed and constructed to withstand the most severe operating conditions. Complete range of types and sizes are available.

RUGGED cast aluminum housings with tight sealing doors and door glass joints—positively dust proof and moisture proof—give maximum protection to reflectors and lamps and reduce cleaning and other maintenance to an absolute minimum.

STRONG, galvanized cast iron bases and brackets of many types are provided for simple mounting and accurate adjustment in all locations.

ADVANCED DESIGN of the carefully molded and highly polished reflectors and lenses insure the highest optical efficiency—thoroughly annealed for maximum toughness.

Write for catalog 2100 giving complete information.

The services of our trained and experienced floodlighting specialists are available at all times to advise and assist in installation problems.

SINCE 1897

THE PYLE-NATIONAL COMPANY

1370 NORTH KOSTNER AVENUE, CHICAGO 51, ILLINOIS

DISTRICT OFFICES and REPRESENTATIVES in Principal Cities of the United States

CANADIAN AGENT: The Holden Co., Ltd., Montreal • EXPORT DEPARTMENT: International Railway Supply Co., 30 Church St., New York

CONDUIT FITTINGS • PLUGS and RECEPTACLES • TURBO-GENERATORS • LOCOMOTIVE HEADLIGHTS • MULTI-VENT AIR DISTRIBUTION

SQUARE D's *New*

SAFETY SWITCHES

***Types A, C and D**

Backed by 40 years' DESIGN LEADERSHIP

The remarkable superiority of this new switch line is reflected in these TYPE A design and operating features:

MODERN STYLING is both functional and attractive.

COMPACTNESS obtained without sacrifice of wiring convenience.

FULL COVER INTERLOCK has attachment that locks switch "ON" or "OFF" with 1, 2, 3 or 4 padlocks of nearly any size or shape.

SIMPLE MECHANISM—quick make-and-break action—no dead center.

SILVER-PLATED current-carrying parts.

EXPOSED BLADES permit visual checks of switch operation.

DEAD-FRONT line terminals are protected by hinged arc chamber cover.

MAGNETIC ARC PLATE adds to unusually high rupturing capacity.

POSITIVE PRESSURE jaws and fuse clips, steel reinforced, silver-plated.

NON-TRACKING insulation used in base. Melamine insulating cross-bar.

REMOVABLE PRESSURE CONNECTORS permit substitution of solder lugs, where preferred.

Types* **C *and* **D** *similar to Type* **A** *in appearance—differ in construction details*

In production: 30 and 60 ampere sizes ...NOW · 100 and 200 ampere sizes ...SOON · Larger ampere sizes ...LATER

Write **for Bulletin 3100 • Square D Company, 6060 Rivard Street, Detroit 11, Michigan**

SQUARE D COMPANY

DETROIT · MILWAUKEE · LOS ANGELES

SQUARE D COMPANY CANADA LTD., TORONTO • SQUARE D de MEXICO, S.A., MEXICO CITY, D.F.

ROTARY AIR COOLING
Preserves Sinter Structure

Rotary Cooler Licensed under U. S. Ser. Nos. U.S. 519322 and 613368

Air cooling is a new development in sinter cooling practice which is rapidly being accepted by the industry because of these advantages:

1 It anneals sinter and avoids the degradation and shattering caused by water quenching. It improves the size and quality of the sinter product.

2 It reduces the percentage of fines as compared to water cooling.

3 It eliminates the undesirable steam and water conditions caused by steam and moisture when water cooling is used.

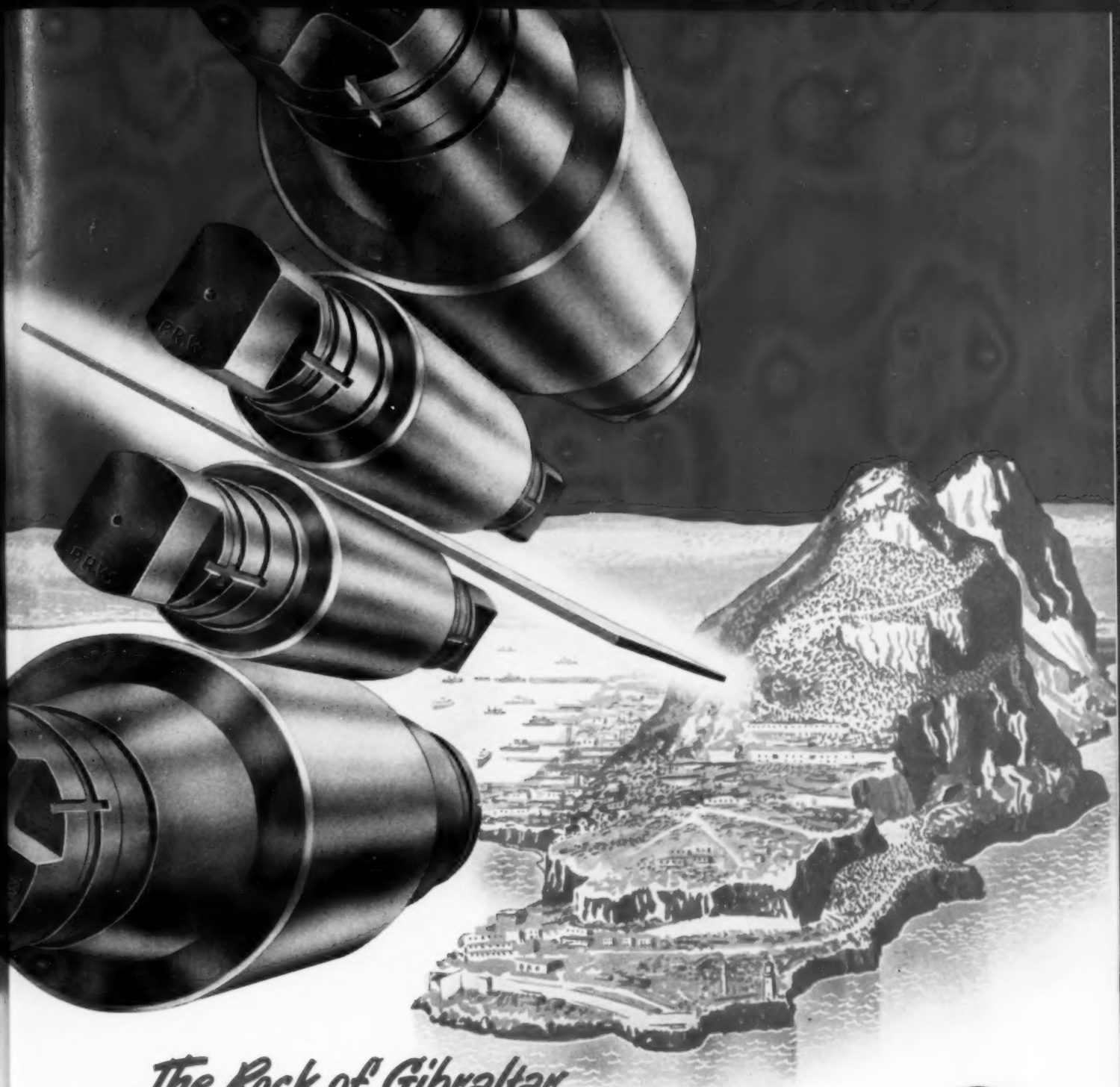
4 With air cooling, the sinter can be distributed by conveyor belt direct from the cooler to any desired location without use of cars.

Complete information about the improved Rotary Air Cooler is available to you upon request.

ARTHUR G. McKEE & COMPANY

DESIGN, ENGINEERING AND CONSTRUCTION FOR THE IRON AND STEEL AND PETROLEUM REFINING INDUSTRIES

ENGINEERS AND CONTRACTORS • ESTABLISHED 1905
2300 CHESTER AVENUE, CLEVELAND
30 Rockefeller Plaza, New York, N. Y.



...The Rock of Gibraltar could be covered to a thickness of 4" with Plate Rolled last year.....

Over seven million tons of plate were rolled last year. This tonnage in quarter inch thickness could cover an area of more than fifty square miles or sufficient plate to protect the massive Rock of Gibraltar with a coating four inches thick.

Rolls with the familiar P.R.W. on the wabbler have played an important part in the production of this tremendous volume. The reason for the wide use of these rolls is their dependable performance under exacting plate mill requirements. The sum total of what P.R.W. rolls mean to the steel industry is expressed in the old and oft proved Pittsburgh Rolls slogan: *less cost per ton of steel rolled.*

PITTSBURGH ROLLS • Division of Blaw-Knox Company • Pittsburgh 1, Pa.

PITTSBURGH ROLLS

Let's look at the record!

Here are five cold strip mills where individual-generator drive systems—originated, engineered and equipped by General Electric—are on the job every day!

All of these mills are in actual operation, rolling thousands of tons of good steel per day. In every case the equipment for its individual-generator drive was engineered and supplied by General Electric. And in every case, it was so well engineered at the factory that it went into successful operation with minimum tune-up delay.

This improved type of steel mill drive was originated and first put to practical use by General Electric. By providing a separate generator for each drive motor, it offers these important advantages:

—**Cuts** equipment and maintenance costs by eliminating the need for high-current series boosters and by decreasing the number of circuit breakers required.

—**Lowers** bus installation costs and makes for a simpler, faster installation.

—**Maintains** proper speed relationship between stand motors at all times by built-in ohmic-drop compensation.

—**Reduces** tune-up time for actual production to as little as three days.

—**Assures** taking full advantage of the inherent speed regulation characteristics of specially designed d-c motors.

Successful installations like these emphasize once again General Electric's ability to handle your drive engineering problems. Why not talk them over with the G-E steel mill engineer in your area? *Apparatus Dept., General Electric Company, Schenectady 5, N. Y.*

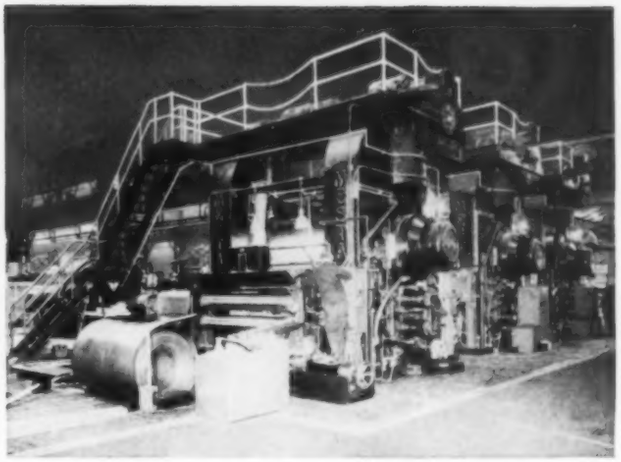
You can put your confidence in . . .

GENERAL ELECTRIC

660-65

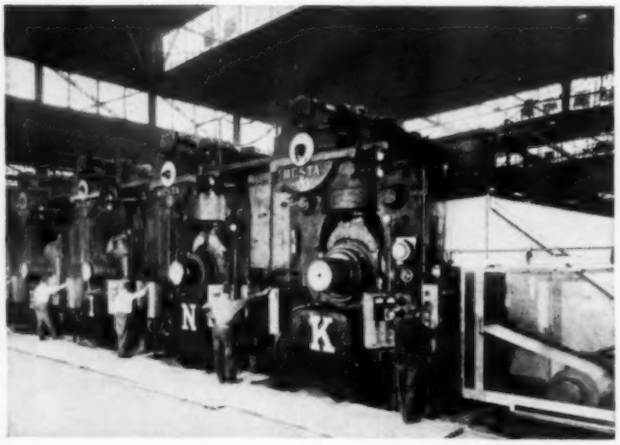
Courtesy Jones & Laughlin Steel Corp.

Fastest of its kind in the world is this 42-inch 5-stand tandem tinplate mill. Put into operation in October 1947, it rolls tinplate at a speed up to 6250 fpm—more than 70 miles an hour. And it rolls up to 851 tons of tinplate per turn!



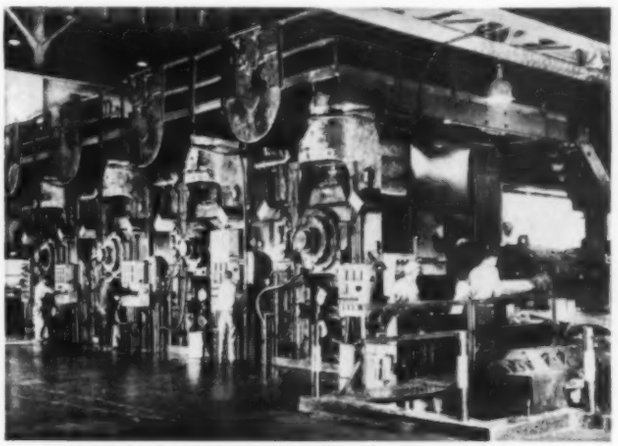
Courtesy Great Lakes Steel Corp.

At a speed of 1600 fpm—faster than any other of its width—this 93-inch 3-stand sheet mill can top all others in tons per hour rolled. Installed in December 1947, its tune-up period took only 3 days.



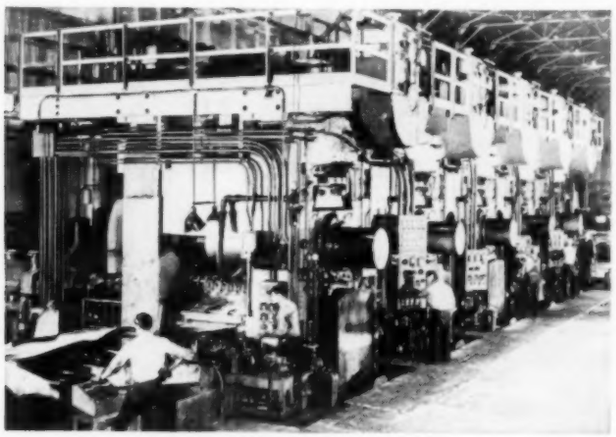
Courtesy Inland Steel Co.

This 42-inch 5-stand tandem tinplate mill began production in December 1948. Its rated delivery speed is 4330 fpm.



Courtesy Carnegie-Illinois Steel Corp.

Placed in operation in June 1948, this 54-inch 4-stand tandem sheet mill has a rated speed of 3300 fpm.

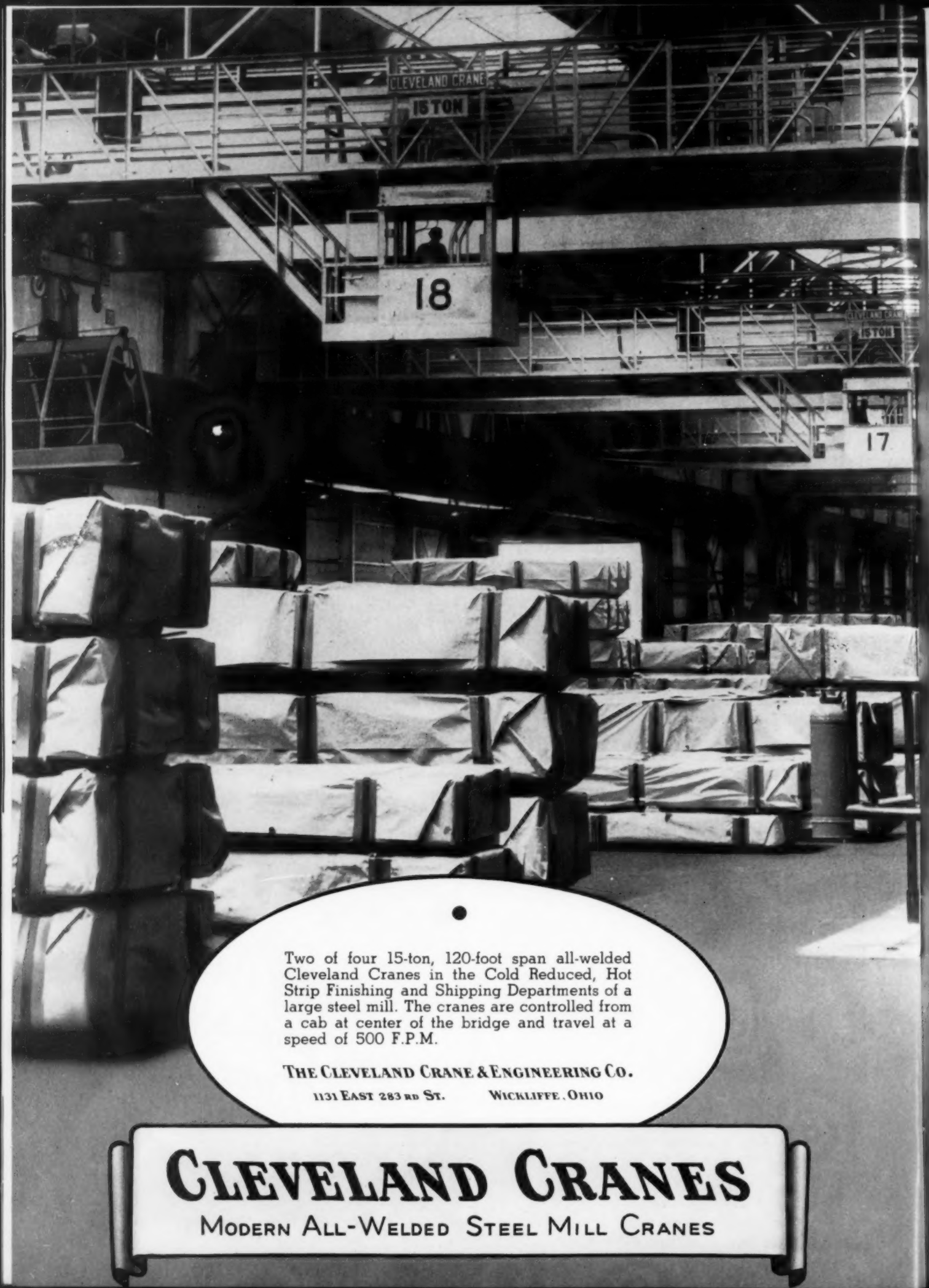


Courtesy Columbia Steel Corp.

First of its type in the West, this 56-inch 5-stand tandem cold strip mill went into production in July 1948. It rolls both sheet and tinplate at speeds up to 4100 fpm.

GENERAL ELECTRIC

drive engineering at work!



Two of four 15-ton, 120-foot span all-welded Cleveland Cranes in the Cold Reduced, Hot Strip Finishing and Shipping Departments of a large steel mill. The cranes are controlled from a cab at center of the bridge and travel at a speed of 500 F.P.M.

THE CLEVELAND CRANE & ENGINEERING CO.

1131 EAST 283 RD ST. WICKLIFFE, OHIO

CLEVELAND CRANES

MODERN ALL-WELDED STEEL MILL CRANES

Crops and Shorts

ALTHOUGH he used provisions of the Taft-Hartley act eight times during 1948, President Truman stated that a strike involving the entire steel industry would now have to continue some time before he would consider it an emergency and again invoke the act. But he did think it critical enough to intervene in a labor-management dispute with his fact-finding board proposal, which is essentially a rewrite of a bill twice rejected by Congress. Public opinion does not permit peace overtures from the president of the United States to be lightly rejected, even when the alternative might be a one-sided fact-finding board.

And so the steel producers are again placed in an unenviable spot by an unholy alliance of government and union. The 60-day delay only draws out the uncertainty. Recommendations will be forthcoming and will superficially appear to be the result of arbitration, even though both parties did not participate in the selection of the arbiter. Public opinion will be whooped up to put pressure on steel producers to accept the recommendations. The scenario is all strangely reminiscent of past performances. Will it have the same ending?

▲

AFTER several weeks of coy silence, the steelworkers finally unveiled their wage demands to exhibit 30 cents per hour (somewhat higher than expected), made up of 12.5 cents direct wages, 11.23 cents for pension ("deferred wages") and 6.27 cents for an insurance program. Mr. Murray says this can come out of the "record profits the industry is piling up." His economic consultant, Robert R. Nathan, after hurriedly revamping his figures, says the same thing. Mr. Nathan, by the way, is the same gentleman who accumulated figures which he says show the break-even point of the steel industry to be at 32 per cent operations.

▲

IN the early stages of the fact-finding conference Phillip Murray's temper overflowed to the extent of calling management representatives to the fact-finding conference a "sanctimonious band of professional racketeers," and then, upon being reprimanded, changed it to "provocateurs and prevaricators," all of which was stricken from the record. Maybe it was the heat, or maybe Phil was trying to ape John L. Lewis. If the latter, he shouldn't step so far out of character.

Other name calling put John L. Lewis on the receiving end. Testifying before the Senate banking committee, Tyre Taylor, counsel for the Southern States Industrial Council, recently said "John L. Lewis has become an insufferable bore. His acting is ham, his utterances corny, his posturing pompous and silly."

▲

ADOLF HITLER'S yacht, the Grille, which recently was on exhibit in New York and Washington, contains a bar built in the shape of the world, and where the U. S. A. should be there is an opening through which the bartender serves. Some people have taken exception to this but, after all, isn't that where all the hand-outs have been coming from?

▲

SUCCESS is the ability to get along with some people, and ahead of others. Another definition calls it making hay with the grass that grows under other peoples' feet.

▲

JUST in case you want to check up on your own performance, we are passing on the results of a national survey of all conventions. The average stay for each attendant is 3.9 days, and his average daily expense is $24, ranging from more than $30 in New York, Chicago and Miami Beach to about $16 in Jacksonville and Long Beach.

The spending is distributed as follows: 25 per cent for hotel rooms, 20 per cent to retail stores, 14 per cent to hotel restaurants, 13 per cent to other restaurants, 7 per cent for beverages, 6 per cent to night clubs and sports events, 3 per cent for local transportation, 1.6 per cent to theaters, and the remainder over a wide range of miscellaneous items.

We'll bet that retail store item varies widely, depending on whether or not the wife is along.

▲

RINGLING'S circus this year has a patriotic pageant, at one point of which a large picture of President Truman is displayed, whereupon the elephants roll on their sides and act dead.

▲

ACCORDING to the "Industrial Bulletin" of Arthur D. Little, Inc., Malaya's tin mines during 1948 regained their position as the world's leading tin supplier, with a production of ore yielding 44,381 tons of tin, not far short of the 1939 figure of 47,416 tons. Exports in 1948, valued at $97,000,000, went principally to the United States, where consumption is off somewhat. Although tin plate output has increased almost 40 per cent since 1939, tin consumption for this purpose has dropped 13 per cent, due to the introduction of electrotinning. Similarly, the use of tin solder has been reduced, substitutes have replaced tin in collapsible tubes to a considerable extent, and nylon has virtually wiped out the demand for tin chloride for loading silk.

▲

IN spite of all the recession worries that are floating about, steel producers are proceeding with many new construction projects, including $12,000,000 for three new 225-ton open hearth furnaces and miscellaneous service facilities at Armco Steel Corp. in Middletown, Ohio; $4,500,000 for revamping the blooming mill so as to roll wider slabs at the Campbell works of Youngstown Sheet & Tube Co.; a new electric-weld, large-diameter tube mill and a sintering plant at National Tube Co., McKeesport, Pa.; new strip finishing facilities at Bethlehem's Lackawanna plant; a tandem cold mill at Thomas Steel Co.; and four sintering plants for Carnegie-Illinois Steel Corp.

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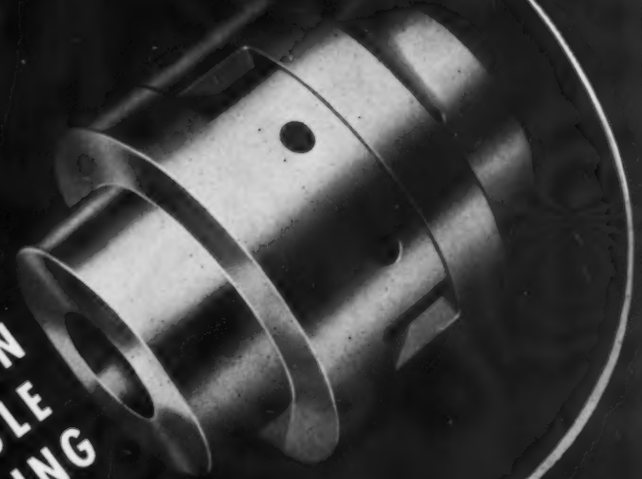

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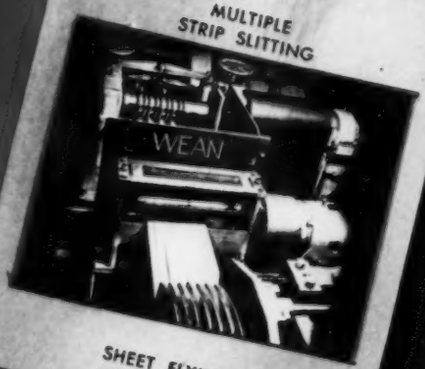
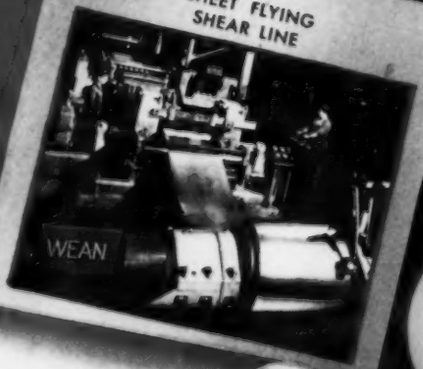

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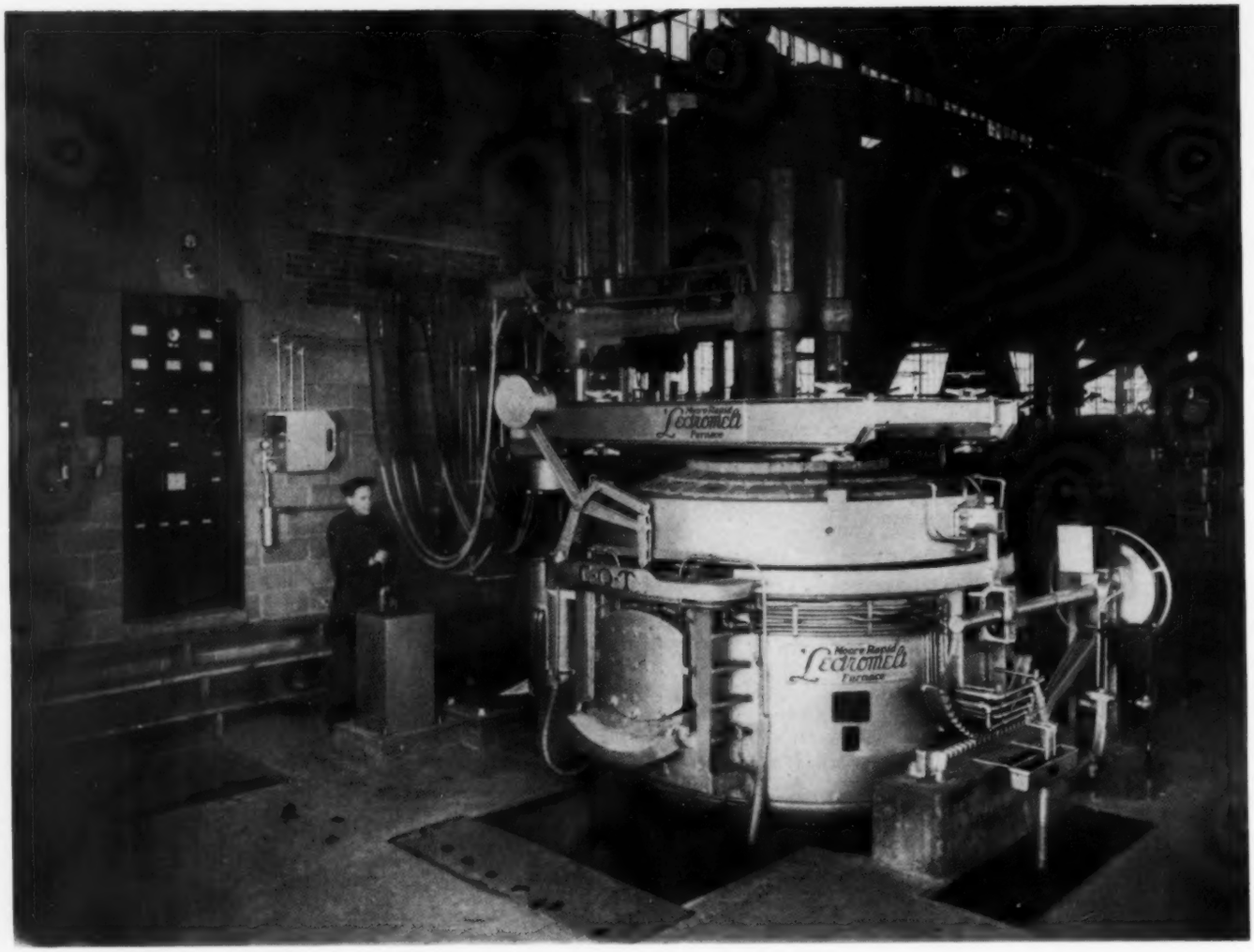

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FLASH WELDING OF WIDE STRIP STEEL

By F. R. THOMPSON and F. J. WALDSCHUTZ

Mesta Machine Co.

Pittsburgh, Pa.

. . . . economical high speed rolling is dependent on the use of large coils, but welding of wide strip for cold rolling has met with many difficulties . . . . the flash welder described, combined with proper procedure, should eliminate many of these problems . . . .

▲ RESISTANCE welding for joining wide strip steel coils has been in use successfully for the past fifteen years. The welding equipment was first developed for Inland Steel Company and used on materials up to 72 in. wide by $\frac{1}{8}$ in. thick. The success of this welder led to the development of still greater machines which today are capable of welding ordinary carbon steel from 12 to 96 in. wide, and from tinplate stock to $\frac{5}{16}$ in. thick. This class of flash welder, which is known as the mechanical type welder, is now used in a large number of steel plants and is still being used in new installations.

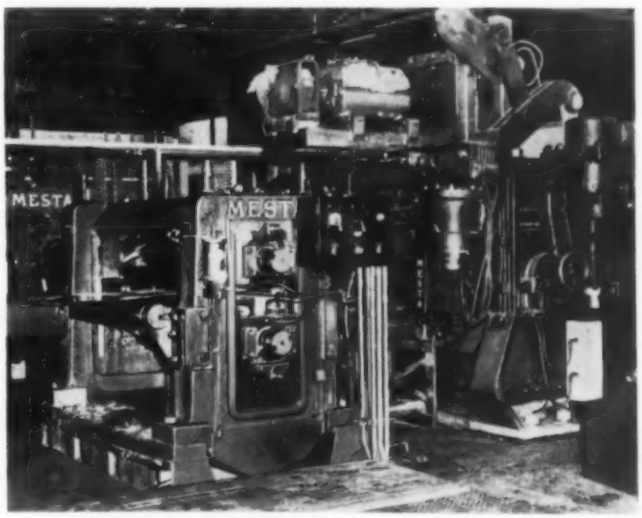
The welder is capable of producing joints that are strong as the parent metal. It makes possible a continuous flow of strip through the pickle line without the welds pulling apart or breaking. It permits the formation of large coils at the upcoiler, consisting of 3, 4 or 5 ordinary hot mill coils. These welded joints are strong enough to permit reducing strip in the tandem cold mills to one-tenth of the entering thickness, and to withstand any further working required for a finished sheet.

Welder design—The mechanical type of flash welder consists of a set of stationary dies mounted in a stationary housing and a set of movable dies mounted in a movable housing. Between the dies is mounted a retractable gage against which the ends of the strip are alined and properly spaced. The strips are then clamped between the upper and lower dies and the gage withdrawn. The gap left by the gage is quickly taken up by cam motion which closes the dies until the strips make contact. The welding heat is automatically turned on before the strips touch. The feeding mechanism slowly moves the ends of the strips together at the proper rate to produce flashing which continues until the strip ends are heated to welding temperature. At this time the push-up takes place, forging the heated ends together and completing the weld. All of these operations are accomplished by mechanical means, all motor operated.

In recent years industry has demanded the welding of high carbon steels, alloy steels including silicon and stainless steels, and some of the non-ferrous metals. Some of these are easily welded while others have not yet been successfully welded on any flash welder. These materials usually require less overhang at start of flashing, the amount of material flashed off is less, the flashing time is less but the flash-off rate is greater, and the amount of material upset during the push-up is greater than with low carbon steels. The clamping and push-up pressures are usually several times those for low carbon steels.

A machine suitable for the various grades of low carbon steels and other weldable materials must have great flexibility and a number of refinements not present in the mechanical welder. It requires a clamping arrangement that can be adjusted for various clamping pressures which differ for various metals and again for various thickness of metals. Too much clamping pressure will mark the sheet and may cause excess die deflection, while too little pressure may cause the strip to

Figure 1 — Entering end of hydraulic welder shows free strip after looper roller was lowered into table. Hydraulic feed metering valve is at left center.



Presented before AISE Annual Convention, Cleveland, Ohio, October 1, 1948

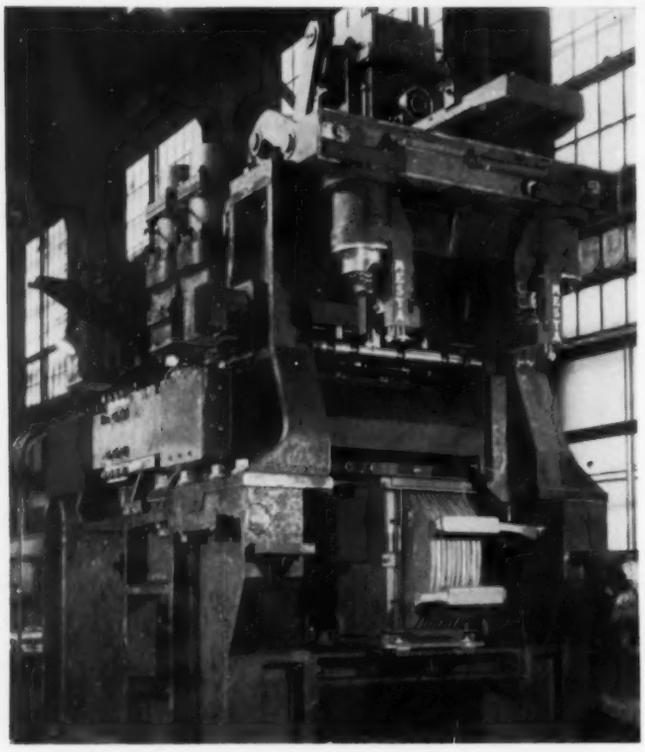


Figure 2 — On delivery side of hydraulic welder is seen side clipper on beam under gage motor. The machine on left is a rotary flash trimmer.

slip, in either case a poor weld is produced. Hydraulic control lends itself very readily to permitting the selection of light pressure for thin gages and heavy pressure for thick gages. A welder having a hydraulic clamping arrangement, but with the conventional mechanical feed and variable voltage control on the feed motor is being used with good success. A later development employs the same hydraulic clamp and also a hydraulic feeding arrangement. This hydraulic feeding is important and is considered in the following description.

After the strip has been gaged and clamped, and the gage has been removed, the two strip ends are the thickness of the gage head apart. This distance varies with the strip thickness and may be from one to three-eighths inches. The gap is quickly closed by an adjustable-stroke air cylinder which advances the movable housing just enough to bring the leading edges of the strip into contact. The welding heat is turned on during the gap closing. The feeding mechanism of the welder slowly moves the strip ends together, and the welding current flashes off the edges at the same rate as with the mechanical machine until the ends reach welding heat.

The rate of approach of the strip ends towards each other is controlled by a hydraulic metering valve. This valve may be set to feed at different rates, the total time varying from perhaps 20 to 3 seconds. The rate of feed also varies during the flashing operations, being very slow at the start of flashing, say 0.01 in. per second, and gradually increasing until just before the push-up when the rate may be 0.1 in. per second. The rate of feed varies not only with the thickness of the strip but also with the material being welded.

With low carbon steel it is possible to obtain good welds over a fairly wide range of different feeds. With alloy steel the settings become more critical, because the rate of feed generally must be much faster to prevent blowing and to maintain continuous flashing to the time of upset. Any metal presents its own problem which must be studied critically to obtain the best welding results. During the flashing time, the die voltage is kept constant at a value which will maintain continuous flashing and yet not flash off particles so fast that heat will fail to build up in the strip ends.

At the end of the flashing period the strip ends are at welding temperature and then the push-up or up-set takes place to forge the strip ends together quickly. The dies hold them in perfect alinement until the weld cools. The speed with which the push-up is accomplished is important, especially with alloy steels. It must be done very quickly or the weld will not be satisfactory. With hydraulic feeding equipment this push-up is accomplished by suddenly changing from a metered flow into the feeding cylinders to a wide open or unrestricted flow. This design produces an almost instantaneous push-up.

Two air-hydraulic intensifier cylinders serve the clamping and feeding hydraulic systems and complete a self-contained hydraulic welding unit.

The electrical equipment for the flash welder is extremely simple and consists essentially of: (a) one or two welding transformers mounted on the welder and connected for uniform current distribution along the entire strip width; (b) an externally located auto-transformer with a manually-operated heat tap-changer; (c) high-speed magnetic contactor for welder duty in the main power circuit; and (d) auxiliary motors, controls, limit switches, solenoid valves, etc., for providing the welder individual motions, also for sequencing and interlocking during the welding cycle. All electrical equipment has the heavy duty construction and capacity features which are essential for pickle line machinery.

The stationary welder head which holds one polarity clamping die is insulated from its grounded base, but the movable head with the other polarity clamping die is not insulated. Because of this construction there is in parallel with the flashing arc a high resistance circuit from the insulated welder dies through the leading strip to the No. 1 pinch roll which is grounded, then through the ground circuit to the processor, and back through the leading end of the next coil to the movable head dies which are not insulated from ground.

Welders which have been built for strip mills range in rating from 500 kva to 2200 kva single phase. Present indications point to three-phase welders in the future.

Recently one 700-kva welder installation has been made employing one ignitron tube contractor instead of the standard magnetic welding contactor for main circuit power. The auto-transformer with its manually operated heat tap changer was eliminated, and there was substituted four taps on the primary winding of the welding transformers to give voltage selection.

Magnetic contactors, controlled by the welder operator, select the desired transformer tap. In addition, phase-shifting control is provided for further heat adjustment on each tap. Because of the importance of this

unit in the production of large coils and the lack of tube life data in such an application, a duplicate ignitron contactor was installed as a spare. For welding ordinary grades of steel commonly produced today in strip mills, the ignitron contactor will give no better performance than the magnetic contactor. For welding certain alloy steels, as well as for aluminum and copper, the ignitron contactor will become a necessity, because the magnetic contactor is not sufficiently accurate in timing for the short power cycle.

Side clipper—The front end of a coil coming from the hot mill varies slightly in width from the tail end. When the two ends are welded together they must be set to have approximately the same overlap on each side. This overlap may cause difficulties in the trimming operation and in guiding the strip through the pickler and the mill. To eliminate these troublesome sharp corners, an air-operated side clipping shear was designed as a part of the welder equipment. This shear consists of two independent shear heads mounted on air-operated carriages suspended from an overhead beam on the welder. This arrangement lends itself to any width of strip. It clips out a crescent-shaped section, thereby removing all projections.

Flash trimmer—The welded joint as it comes from the welder is considerably heavier than the strip and must be trimmed as close as possible to the correct strip gage. Here again there is a difference in the strip ends of the coils. Invariably the front end of the coil, which is the tail end coming from the hot mill, is from 5 to 10 thousandths heavier than the other end of the coil, which fact presents certain difficulties in trimming. There are three distinct types of flash trimmers in use.

The most common type in use is the plow type trimmer which uses a stationary plow-shaped knife arrangement. The knives are closed and the strip is trimmed, both top and bottom, while in motion, hence no time is lost in stopping the strip, alining the weld, and then trimming the weld before resuming line speed again. This machine must be set to trim over the heavy gage, hence it will leave a slight ridge on the light gage side.

Another type of flash trimmer in use is the cross-cut type with multiple cutting knives. This machine removes the flash from a level strip very satisfactory while the weld is stopped in the trimmer.

A recent development is a flash trimmer of the rotary type. This type of trimmer removes the flash down to the level of the lighter gage strip. It requires accurate stopping of the strip in the trimming position. This type of machine is in successful operation and is being further developed for tin plate gages. Automatic control may be employed to start the strip after the completion of the weld and then stop it automatically and accurately at the side clipper, then again at the flash trimmer.

Factors in successful welding—In the hand arc welding field, a person of considerable training in a school for that purpose prepares two pieces of steel according to accepted methods and fuses them together employing a special welding rod for working within a small area. He will tell you that unless the proper procedure is followed a poor weld will result. In case of doubt of a weld condition, by extending the time of welding he can easily increase the welded area and his factor of safety.

In the welding of strip steel for sheet and tin plate coils, the ratio of width divided by the thickness of strip is never less than 100 to 1 and is frequently several thousand to one. Because of the extreme reductions in thickness when passing through the tandem mill the strip must be almost perfectly welded over the entire width. A satisfactory weld can be produced only by attention and action with respect to the following four factors:

1. Material—The material must be uniform throughout any coil, and from coil to coil. A change in material analysis means a different welding technique, whereas a standard procedure must be followed in a pickle line. Uniformity of material means no segregation of impurities, no extreme pitting of the surfaces, and no pipe in coil ends. Piped ends cannot be welded and rolled, hence this material should be cut off and scrapped before pickle line processing. Uniformity of gage and width is also essential.

2. Welder machine—A major change in strip gage and width may require a different clamping pressure, different amounts of material flashed off, different amounts of material upset during the forging operation, different timing for the power cut-off, etc. The welders available today incorporate all the necessary functions.

3. Welder operator—This is probably the most important factor in successful welding. A properly designed and installed welder machine is dependent upon the operator, hence he must be given adequate training in how to set-up the machine, load the work, and judge the result. He must be given the necessary set-up data regarding the voltage, flashing time, strip overhang at the beginning and end of the cycle, and other data. The man must be trained to use judgment in recognizing favorable and unfavorable signs. If he knows that the flashing time is less than the set-up given to him then adequate heating will not result and the weld will be poor. The welder machine is fully automatic in its cycle but it requires a trained operator to make it produce.

4. Set-up factors—Under this heading come these

Figure 3 — Delivery side of plow-type flash trimmer. Knife opening is set by adjustment of the rollers hence is correct for any strip gage.

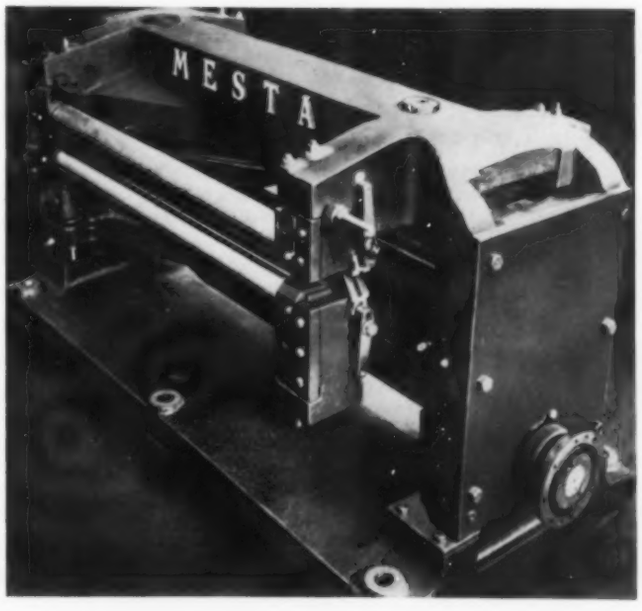


TABLE I

Material	Carbon	Manganese	Silicon	Chromium	Phosphorus	Copper	Other alloys
A	0.18	0.75	0.90	0.65	0.20	0.25	0.20
B	0.25	1.60	0.30	....	0.045	0.20	0.05
C	0.10	0.30	1.00	1.00	0.20	0.50	....
D	0.08	0.50	0.40	0.50	0.10	0.50	0.35

important factors: (a) both ends of the strip must be cropped so that when clamped in the dies they will meet in the same horizontal plane without either or both ends being turned up or down; (b) the clamping dies must have square corners at the strip overhang; (c) the strip overhang must be the same on each pair of dies; (d) the strip must not be forced against the gage to cause either strip end to turn up or down; (e) the strip ends from the hot mill will be of different thickness, hence the lower dies must be properly alined in elevation to care for approximately one-half of the average gage difference; (f) the strip ends must be centered symmetrically over the width; (g) the initial and final die gap, the timing rate, and the power cut off point in the cycle must be selected from the welding chart provided to the operator at the time the welder is installed.

Welder application—The economy and convenience of scheduling production with large coils instead of small coils is easily understood. Today, we have modern high-speed tandem mills for tin and sheet stock. These high-speed mills would not be practicable without welded coils, hence the welder is an absolute necessity in the pickle lines serving these tandem mills. This is illustrated by a comparison of production from a 1500 fpm tandem mill rolling 29 x 0.01 in. coils with 20 in. inside diameter and 38 in. outside diameter coils weighing 6000 lbs, to production from a 5000 fpm mill using the same 29 x 0.01 in. stock but welded into 58 in. outside diameter coils weighing 18,000 lbs. The electrical equipment will accelerate both mills to full speed in about 8 seconds during which time most of the material will be off-gage. Approximately the same time of 8 seconds is required for stopping the mill, and again the material rolled during deceleration will probably be off-gage. The material rolled at constant speeds of 1500 fpm and at 5000 fpm, respectively, on the two mills will be considered to be on-gage.

On the 1500 fpm mill using 6000 lb coils, 96.5 per cent of the material is on-gage to give 22.5 net tons per hour (using 80 per cent rolling efficiency); with 18,000 lb coils. 98.8 per cent of the material is on-gage to give 29.9 net tons per hour.

On the 5000 fpm mill and using 6000 lb coils the on-gage material is 89 per cent to give 38.3 net tons per hour; with 18,000 lb coils 96.4 per cent of the material is on-gage to give 72 net tons per hour.

Welders have found an application in the production of 10,000 lb coils from 2,000 lb coils in one mill where the small coils are produced in a reversing hot mill equipped with furnaces on each side of the mill. The welder is located in the pickle line. Another welder application is to produce large coils from 20-ft long sheets for a continuous processing line. The program under consideration requires a separate welder line with one or two welders, and another welder in the processing line.

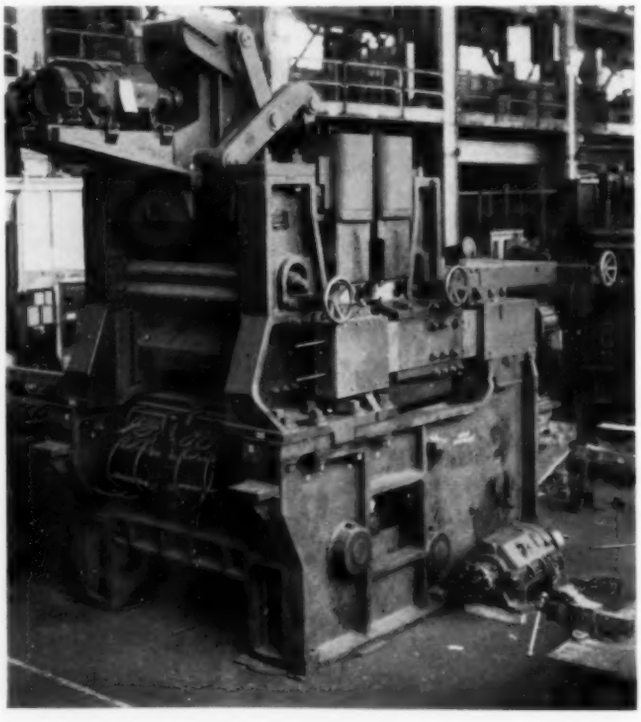
Additional application of welders now in production include several for materials containing high percentages of alloys. (See Table I)

Discussions of welders cannot be complete without pointing out the fact that the basic design of welder machine for strip steel is also suitable for welding the non-ferrous metals such as aluminum and copper. The power requirement and flashing time will be materially different. Three welders were built several years ago for welding small coils of copper-clad steel strip into large coils for later processing in a tandem cold mill. These same three welders are also used for welding together strips of low carbon steel.

Results—The advantages of welding small coils together are lost if the weld breaks in the tandem cold mill. An inspection of results obtained from welders in proper adjustment and with a trained operator shows that the number of breaks in the heavier gage materials is negligible, generally being no more than the average number of breaks occurring in the strip not near the welds.

In the light gage field covering essentially tinplate stock we have one typical record of 386 welds with 1.3

Figure 4 — Shop view of mechanical type welder. Note insulation between upper and lower castings on stationary head and on slide for movable head. Water connections for the transformer are not required for pickle line application.



per cent breaks in the weld as it was rolled in the tandem mill. These are for normal production without any special supervision of the welding set-up or operator. In one special application a record of over 1900 net tons of welded coils were rolled in a high-speed mill during a 24-hour period with 0.8 per cent weld breaks. The exact number of welds was not recorded but from the average coil size it must have been close to 500 welds. In both of these cases no record was kept of the number of strip breaks in the material outside of welds. Mills with modern electrical controls provide better indication and regulation of strip tension between stands, hence fewer breaks may be expected. It has been found that weld rolling speed is close to normal running speed on these mills. Welds have been rolled successfully at more than 5000 fpm strip speed.

The weld is rejected in tinplate stock as it passes through the tin shear line. Usually several sheets on each side of the weld also are rejected because of gage. In the case of sheet stock the sheet containing the weld is usually passed along as a prime sheet. A little putty and paint will permit the use of that sheet in your new model automobile top.

DISCUSSION

PRESENTED BY

C. J. BOEHME, Foreman, Cold Strip Mill, Campbell Works, Youngstown Sheet and Tube Co., Youngstown, Ohio

F. J. WALDSCHUTZ, Mesta Machine Co., Pittsburgh, Pa.

L. J. TREWARTHA, Chief Electrical Engineer, Great Lakes Steel Corp., Detroit, Wis.

W. H. WRIGHT, Weirton Steel Co., Weirton, W. Va.

Carl Boehme: Is the hydraulic installation more expensive or less expensive than an electrical and mechanical installation of the same type?

F. J. Waldschutz: They are about the same cost.

Carl Boehme: Would the mechanical upkeep of the hydraulic welder be any simpler than on your present mechanical unit?

F. J. Waldschutz: We think it is. For clamping various grades of strip steel, clamping pressure varies and hydraulic lends itself best for this purpose. It gives a greater range between minimum and maximum pressure. It cushions the movements and it eliminates a multiplicity of mechancial equipment. The speed for the proper upset or pushup is very important and a fast speed such as is required for alloy steel can easily be obtained with hydraulics. The entire design of the welder becomes much simpler, the upkeep becomes considerably less, shutdowns are less frequent, because properly serviced hydraulic equipment requires a small amount of actual maintenance work.

Hydraulic packings must be of a grade suitable for oil and temperatures up to 120 F. Any packing, regardless of whether it is oak-tanned leather, composition or synthetic material, will answer the requirements provided it fits properly and is maintained by systematic inspection. Hydraulic pressure range varies from 400/1600 psi for clamps and 2500 psi maximum for pushup. Variation of hydraulic pressures is obtained by varying air pressures on intensifier cylinder.

Carl Boehme: Is it necessary to keep the oil in the hydraulic system at a constant temperature in all seasons in order to get efficient operation?

F. J. Waldschutz: It is necessary to a certain extent. I will read to you the material specifications for the oil requirements:

a. The oil must be unusually resistant to chemical change.

b. The oil must have the ability to separate quickly from moisture.

c. The oil must have a maximum film strength to withstand severe pressure and fairly high velocity—from 50 to 350 ft per second.

d. The oil should have a viscosity of 150 to 325 maximum S.S.U. at 100 F and at the same time a minimum change in viscosity for small temperature changes, or in other words have a good viscosity index.

The above specifications are found in a straight mineral oil of the turbine type. Synthetic oil or oil containing additives or inhibitors is somewhat troublesome when used in very small orifices under high pressure. The oil used in the hydraulic system must be clean and free from all solids and other impurities; it should be carefully filtered.

Carl Boehme: At the present time we run into trouble every once in a while. We get some strip from the hot mill that is not very flat. When we get this steel we get a high trim, and of course when it rolls on our tandem mills the trim tends to roll back over and cut off the strip.

With your rotary trimmer, would it be possible to trim closer to strips that are not flat?

F. J. Waldschutz: There is no trimmer that will trim an uneven or wavy strip satisfactorily.

Carl Boehme: In other words, regardless of what trimmer we have, we would still have the same trouble?

F. J. Waldschutz: I would say the rotary type trimmer will do a better job, and give a closer trim; however, the trimmer cannot compensate for a poor strip.

Carl Boehme: Does not the rotary type trimmer have two rotating heads each with its own set of knives, one on top of the other?

F. J. Waldschutz: That is right. The strip stands still. The two heads rotate.

L. J. Trewartha: The steel industry of today is vitally interested in the welding of high tensile steels. The accomplishments up to the present time are not entirely satisfactory. We must be able to consistently weld high tensile steel of various gages and widths suitable for cold reduction with minimum breakage. Unless we can do this, the process is impractical from a production standpoint.

We have four continuous pickling lines, each of which is equipped with one of the welders described.

We now have in our continuous pickling lines two 93 in. welders and one 42 in. welder equipped with the latest devices available for welding high tensile strip

steel. Two of the machines have hydraulic clamps. The third machine has motor-driven toggle clamps. All have motor-driven pushup cams arranged for variable voltage control.

We have done much experimenting and have made exhaustive tests on various gages of steel. As a result, we have learned to weld the heavier gages without much difficulty, but have never been quite successful with the lighter gages, particularly 0.070 to 0.075 in., by that I mean a weld that will stand cold reduction without too much breakage.

Considerable experimental work can and should be done to adapt the welder to the steel or provide a better method of welding. Either the flash welding method itself is basically wrong for this type of steel or it is not being properly applied.

We have several installations of inert gas welding equipment which have proved very successful up to about 11½ in. wide. These welders are installed in front of our continuous roll forming machines. The advantage of this type of welding over flash welding is that there is no flash to be removed.

We have also investigated and are very much interested in the submerged arc welding process of joining two wide pieces of strip steel. We have done considerable work with several manufacturers towards the development of suitable equipment for this type welding of wide strip material. We are very much interested in this type of welding because of the absence of the flash.

In our opinion, one of the most serious objections to flash welding as we know it today is the trimmer, and our inability to always trim as close to the virgin metal as we should because of wavy steel or improper setting of the trimmer knives. We believe this objection is inherent in both of the known and used trimmers in existence today.

The flash welder, which Messrs. Waldschutz and Thompson have so ably described in their paper, so far as we know is the best available today and, in general, gives fairly good satisfaction when all of the mechanical parts are maintained as they should and no steel of unusual analysis is put through the welder. We believe that a continuous study of the existing equipment as we have it today will no doubt result in considerable improvements and simplifications. We would like to suggest that the importance of properly welding strip steel, so that it can be cold rolled without breaking, deserves the careful thought and consideration of all the members of our Association who have anything to do with this type of equipment.

W. H. Wright: The heat line is very important in this type of welding and die maintenance plays a very important part. If the dies are left in operation too long, a poor weld will result, and in grinding of the dies care must be taken to eliminate all low spots or the heat line will vary and again poor weld results.

The difference in the width of the strip from the front to the tail end of the coil was brought out, and this is charactersitic of all coils rolled on any hot mill. The paper also brought out that a side clipping shear was necessary to take care of the difference in the width of the strip.

We at Weirton have eliminated the side clipping shear and find no difficulty in guiding the strip. We aline the strip on the operator's side of the line, and leave all of the extra width on the opposite side. The guides in the looping pit on the entering end of the first tank are set approximately two inches more than the strip width, and the offset in the edge of the strip passes through without any difficulty. The guides at the carrying rolls between the tanks are open to full width, for the protection of the side of the tanks only. The carrying rolls between the last pickle tank and the rinsing tank are set slightly out of line. This causes the strip to ride to one side only.

Two 4-in. diameter vertical rollers are used on this side of the line as guides. All of the material going through our pickling lines is side-trimmed, and the side-trimmer is set slightly out of line for the same reason, as it causes the strip to ride to one side. The vertical roller side guides on the trimmer, on the side that the strip rides to, are set and control the side scrap. The other side is opened to allow the offset in the strip to pass. The elimination of the side clipping shears on our pickle lines has increased the tonnage approximately 60 tons in eight hours.

WANTED!

There is a constant demand for copies of "The Modern Strip Mill", published by the Association of Iron and Steel Engineers.

If your copy is not in use please get in touch with us.

ASSOCIATION OF IRON AND STEEL ENGINEERS, 1010 EMPIRE BLDG., PITTSBURGH 22, PA.

Liquefied Petroleum Gases

FOR THE STEEL INDUSTRY

By FRANCIS E. DRAKE
Vice President and Chief Engineer
Pacific Gas Corp.
New York, N. Y.

. . . . natural gas shortages in winter have sometimes reduced steel plant operations . . . . liquid petroleum gas storage offers one way of preventing such shut-downs . . . .

▲ AT Houston, Texas, in May, 1948, there met in conference some of the ablest leaders of the natural gas industry in this country to talk, not about sales, but how to improve delivery facilities to the hard-put industrial centers of the country. This meeting was held in the heart of the most abundant gas-producing area in the world. The irony of it all was that while this assemblage sought to provide ways and means for increased transportation of gaseous and liquid fuels to distant markets, billions of cubic feet were going into the air by being burned at the flare head in the surrounding oil and gas fields and at the refineries.

Flare gas—The great problem of flare gas has become one of acute concern for not only the forces of conservation but for the oil and gas industry as well. It is quite easy to say "stop burning the gas," but it is much more difficult to do so. It resolves itself into an economic question based upon not only quantity, quality and life of the reserve, but also upon price and distance from the market.

In Texas alone, 1,500,000,000 cu ft of gas is burned at the flare each day. The oil industry is said to be spending $100,000,000 for plants to process this gas, but notwithstanding all efforts in that direction, the volume of flare constantly increases.

A Texas-to-California natural gas line with an ultimate capacity of 900,000,000 cu ft daily is under construction at a cost of $140,000,000. Of the 900,000,000 cu ft of gas to be sent to California, it is estimated that 550,000,000 cu ft will be flare gas which is now being wasted.

Casing head gas—At the Houston meeting of the American Gas Association it was reported by one engineer that Texas is producing from oil wells 300,000,000 to 400,000,000 cu ft of casing head gas daily, and that since September 1945 a total of 46 plants have been built, 22 more are being constructed, and 30 additional plants are projected. When all are in operation they will handle 1,000,000,000 cu ft a day.

Projected gas lines—Each month the gas journals report projected lines from the rich Texas-Oklahoma-Louisiana gas and oil fields to the already-established markets in the midwest and on the Atlantic seaboard. The Tennessee Gas Transmission Co. which originally petitioned the Federal Power Commission for a line to Boston, has of late amended its application for a terminus at Buffalo, N. Y., later to continue on to Boston.

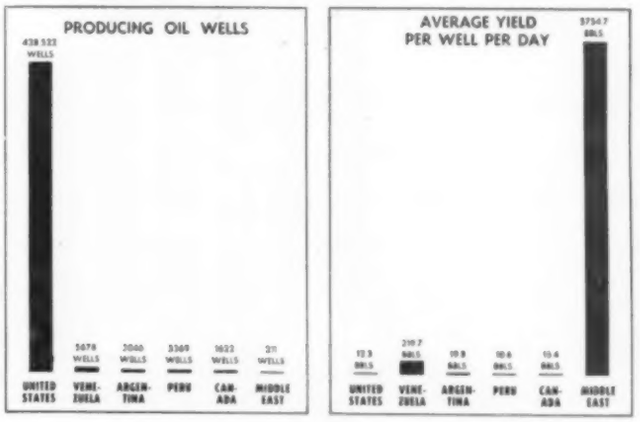
The Federal Power Commission has lately approved construction of a $151,000,000 pipe line by the Trans-Continental Gas Pipe Line Co. to bring natural gas from Texas to the New York-Philadelphia area. The 1,840 mile line, which will be ready by fall of 1950, will have a capacity of 340,000,000 cu ft per day.

Commonwealth Natural Gas Corp., Atlantic Seaboard Corp., and Virginia Gas Transmission Corp., have each requested transmission facilities from various fields to industrial points of importance.

The projected line of approximately 1000 miles of the Tennessee Gas Transmission Co. would include 395 miles of 26-in. line from Kentucky to Buffalo and would cost roughly $123,400,000.

A Texas-to-Keokuk line, 30 in. in diameter and 855

Figure 1 — The number of oil wells and daily well output are given in this chart for the principal oil producing areas for the year 1947.



Presented before the AISE Annual Convention, Cleveland, Ohio, September 30, 1948

miles long, at a cost of $74,000,000, is also on application with the Federal Power Commission.

The Little and Big Inch Lines, on which so many steel plants depend, are being augmented at great expense by the addition of parallel loops as well as repumping stations. According to President Hargrove of the Texas Eastern Transmission Corp., the daily deliveries during April 1948 were 225 per cent over the same period last year. This covered only the first phase of their program. The second phase, when completed shortly, will increase deliveries by 40 per cent up to 433,000,000 cu ft per day. By January 1, 1949, they hope to have the daily capacity up to 508,000,000 cu ft.

Many other lines are either under way or projected, such as the projected 24-in. line to Atlanta, Ga., of the Southern Natural Gas Co., and their 16-in. trunk line through Georgia into Florida and South Carolina. The total mileage of pipe required on these two lines will be 600.

The United Gas Corp. is seeking approval for construction of 1,530 miles of transmission and accompanying facilities. This line would extend from Mississippi through parts of Alabama, Georgia, Florida and South Carolina.

In all, some 9 projects have been approved by the Federal Power Commission, and 19 more are before them for consideration.

Steel demands by gas industry—The question probably uppermost at this point is, "What has all of the foregoing to do with the steel industry and the application of liquefied petroleum gas thereto?" It has much to do with steel operations. The steel industry with its magnificent contribution to the advancement of the United States, as well as the world, is aided by gas, and particularly natural gas because of its high fuel value and low cost. On the other hand, the advancement of gas engineering, and particularly long-distance, high-pressure transmission, is entirely dependent upon the steel industry. In the gas magazines a month or two ago, there was given a summary of the steel requirements of the gas industry over the next 18 months. Without going into detail, but summarizing briefly the results of a comprehensive survey made and submitted to the Steel Advisory Council of the Department of Commerce, we find the following:

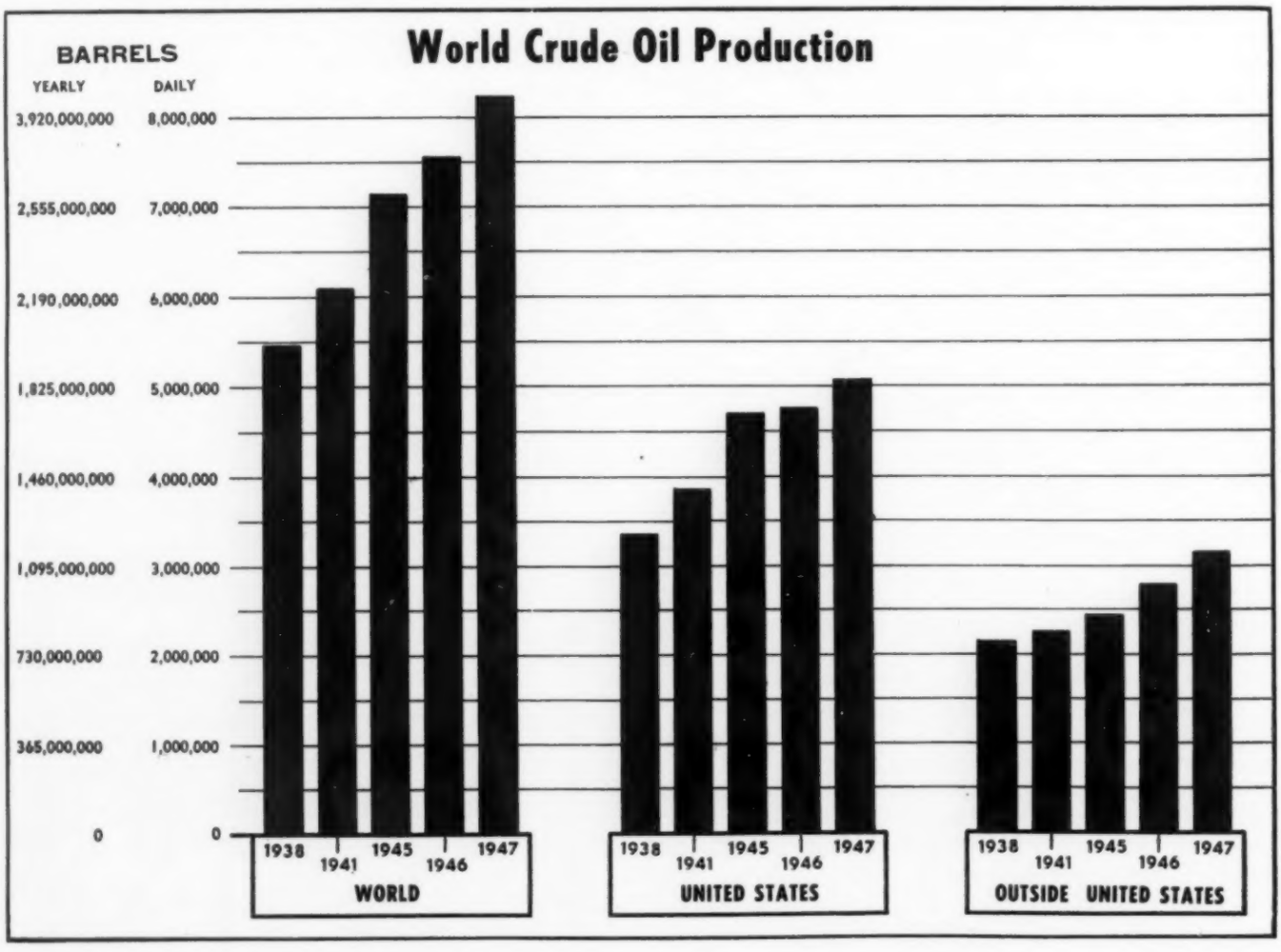
For the third and fourth quarters of 1948, and the first, second and third quarters of 1949:

Natural Gas Department.....2,217,400 tons

(All but about 53,000 tons of this will be required for pipe lines.)

In addition to the foregoing, plant (natural, manufactured and mixed) and distribution facilities will require 1,017,300 tons for the same period of time. Here is an impressive total of 3,234,700 tons of steel required by the gas industry over 18 months. This is 4 per cent of the total steel output, which really becomes disturb-

Figure 2 — More oil is produced in the United States than in any other section of the world.



ing when it is realized that the 1947 production of pipe was but 1,200,000 tons, and that the total oil and gas pipe indicated as definitely needed is 3,838,000 tons. Another serious factor is that the pipe required from this time forward is of larger size than formerly. Whereas the average tonnage per mile of pipe required in 1938 was 86, in 1946 it had jumped to 171½ tons. This was due to the fact that from 1937 to 1941 the following pipe size ratios prevailed:

12 in. and under	49 per cent
14 and 18 in. group	19 per cent
20 and 26 in. group	30 per cent

In 1946 the ratio had changed materially, and from this time forward the prediction is for still larger sizes:

	1946	Future
12 in. and under	17 per cent	3 per cent
14 and 18 in. group	26 per cent	5 per cent
20, 26 and 30 in. group	56 per cent	92 per cent

In terms of the steel making capacity of the United States the tonnage is not great, being slightly less than 4 per cent of the yearly production. The State of Pennsylvania alone accounts for over 28,000,000 net tons annually, while the country as a whole in 1947 totaled 84,783,981 net tons.

Natural gas sales and reserve—Now let us look briefly at the sales and reserve picture of the natural gas industry:

Natural Gas Only

	1947	1946	Per cent change
Total customers	10,268,000	9,582,000	+ 7.2
Industrial customers	37,000	37,000	0.0
Total gas sales, m cu ft	2,503,637,000	2,194,948,000	+14.1
Industrial gas sales, m cu ft	1,504,911,000	1,354,560,000	+11.1
Total $ revenue	$855,185,000	$712,804,000	+20.0
Total $ industrial sales	$272,417,000	$235,201,000	+15.8
Average price per m cu ft, total sales	0.341	0.325	...
Average price per m cu ft, industrial gas	0.181	0.173	...

Col. Ernest A. Thompson, Chairman of the Railroad Commission of the State of Texas, in reporting on natural gas for that state, shows that the increase of production in 1947 over 1939 has been 157 per cent. He also shows that there are in the state 927 gas fields with 8,724 wells, of which 5,311 are producing. The remaining 3,413 are shut in. This simply means that here is additional gas for the market without further drilling if, as and when transportation is available. Col. Thompson also points out that the gas reserves of Texas amount to 56.5 per cent of the nation's total. Sixty-four new fields were discovered in Texas in 1947 and 56 new reservoirs in old fields. Also, 18,336,669 barrels of butane and propane were produced during 1947, which was an 80 per cent increase over 1945.

Here is a cheap, efficient fuel of which much is being used, and as time goes on more must be used to offset solid fuel which is increasing so rapidly in cost.

Reserve life—What about the life of natural gas reserves. According to the latest report of the American Gas Association Committee for the year 1947 there had been an increase of reserves during the year of 10.98 trillion cu ft., leaving reserves as of December 31, 1947 totaling 165.93 trillion cu ft. This is a tremendous backlog of perfect fuel if waste is eliminated and if, as and when pipe line transportation facilities are available. A life of more than 60 years is predicted based upon present day consumption. New fields are constantly being opened up and deeper drillings are finding greater quantities, so the chances are that many years will elapse before natural gas will pass out of the industrial picture of the United States. Efficiency, however, in production, transmission and utilization must be the key-word, and as time goes on only the more refined operations will be able to afford to use this most perfect of fuels.

In view of the quantities of natural gas available for not only the home but industry, it may well be asked why the continued winter shortage? Indirectly, the answer to this question is given in the first paragraph of this paper. It is a matter of transportation from the distant producing fields to the midwestern and eastern markets. It is assumed that gradually this situation will be remedied as additional pipe and pine lines with pumping facilities are made available. History, however, has a way of repeating, and the history of the natural gas industry has always been that the load and demand has invariably grown faster than the transportation facilities.

In Columbus, Ohio, as a youngster, I remember very distinctly my father removing the gas burners from the furnace of our home in mid-January and going back to good old Pocahontas coal so that we might keep warm. That same condition has been repeating itself periodically ever since natural gas first came into prominence. Supply has never been able to keep up with demand, largely from lack of adequate pipe lines rather than because of diminished fields, for when one field nearby has gone out of production another farther away has been discovered and brought in. At the present time, whereas geologists give the Ohio, Pennsylvania and West Virginia fields but a few years longer life, they give the Kansas fields 66 years, Texas some 40-odd years, and Louisiana 36 years at present-day production. However, do not forget that the nearby fields when exhausted, if under the control of one company, can be used for underground storage, pumping in during the summer months, and withdrawing on peak. This is being done today in many instances.

Petroleum supply—The World Oil Atlas for 1948 presents some interesting and illuminating figures on the oil situation which is indissolubly tied in with both the gas and steel industries. See Figure 1. All the following charts are from this Atlas.

In 1947 the world oil demand exceeded the supply. The petroleum demand averaged 8,737,000 barrels daily. This was 1,000,000 barrels per day greater than for 1946.

The world supply of petroleum (crude oil, gasoline and synthetic products) totaled 8,702,600 barrels daily during 1947. See Figure 2 for crude oil production.

Whereas demand increased at the rate of 12.4 per cent, the supply increased only 9.7 per cent. The United States accounted for 5,449,200 barrels daily during the year, and this was an 11 per cent gain over 1946. This country and Canada used up every gallon of crude oil produced and, in addition, imported for refining 310,500 barrels each day.

The two surplus-producing sections of the world are

the Caribbean area and the Middle East group of Asia, Figure 3. Those sections produced one-fourth of the world's oil supply and utilized but 4 per cent. Combined, these areas exported 1,808,300 barrels per day to fulfill the requirements of other parts of the globe. Of the foregoing figure of daily export, 1,136,800 gallons came from the Caribbean countries.

The Middle East embracing Iran, Iraq, Bahrein, Saudi Arabia and Kuwait increased its daily production up to 840,300 barrels in 1947, and within a few years, if the pipe lines in that area now under construction and/or projected are completed, will supplant the Caribbean as the world's largest surplus producing area.

Petroleum reserves—The reserves throughout the world, actually proved by drilling developments at the end of 1947, are estimated at 61,683,035,000 barrels. This represents a figure 20½ times greater than the amount produced in that year. Almost 35 per cent of the estimated proven reserves are located in the U.S.A. where production during 1947 was 61 per cent of the output of the world. The crude oil reserves in this country are 11.6 times greater than the 1,856,107,000 barrels produced. The Middle East, excluding much probable but not proven, has at the present time a proven reserve almost as great as the U.S.A. The largest single reserve in that section is in Iran, which is 5,626,000,000 barrels, or 9 per cent of the world's total. Iraq comes second with 5,000,000,000 barrels, or 8 per cent of the world's total. Kuwait has 4,500,000,000 barrels. South America has reserves estimated at 15 per cent of the total world's supply with 9,651,000,000 barrels, of which amount 8,350,000,000 barrels are in Venezuela. Last year Venezuela produced 14 per cent of the world's output, while holding 13 per cent of the reserves.

European reserves are but 13 per cent of the world's total, of which amount 12 per cent, or 7,500,000,000 barrels are in the U.S.S.R. Outside of the U.S.S.R. the European reserves total but 788,700,000 barrels, or only 1.28 per cent of the amount in the entire world.

These latter figures show us most clearly why Russia, like the story book camel, is determined to get her nose and eventually her whole body into the Middle East tent.

Refineries—Reserves are of little use without pipe, boats, tank cars and refineries. A survey of operators indicates that notwithstanding a scarcity of steel (and they state, "for which there seems little hope of immediate relief") the oil industry of the United States hopes to drill 35,000 wells during 1948. Since the average depth of all wells drilled in 1947 was 3,400 ft., this means that 22,500 miles of pipe will be required in 1948, and this the steel industry must furnish. Added to the steel required for wells must be steel for additional refining capacity, for at the end of 1947 there were 762 plants in operation with a total capacity of but 7 per cent in excess of last year's production.

North America has two-thirds of the world's refineries, with 453 plants. See Figure 5. South America has 53 plants. In Europe there are 141 refineries, many still being rehabilitated from war damage. U.S.S.R. is an unknown factor from a refinery angle. Great Britain and France are both exerting great endeavors to increase refining at a rapid pace, but remember that European daily crude production is at present but 132,095 barrels.

The Middle East has but 9 refineries. The Far East has 31 refineries, of which many are still being rebuilt from war damage.

Italy, The Netherlands and Sweden are planning refinery construction. In fact, one refinery is under way at Amsterdam and is scheduled to produce early in 1949. However, each of these three countries has to import all crude. Only Sweden has shale available for a very limited yearly production.

With the foregoing natural gas and oil background we are now in a position to more clearly understand liquefied petroleum gases and their position in the gas and oil industries, as well as their potential relationship to industry in general and the steel industry in particular. These gases, the principal ones of which are propane (C_3H_8) and butane (C_4H_{10}), are produced both from natural gas by high compression and condensation as well as at oil refineries. While not the first "bottled gas," propane and butane have developed into the most important.

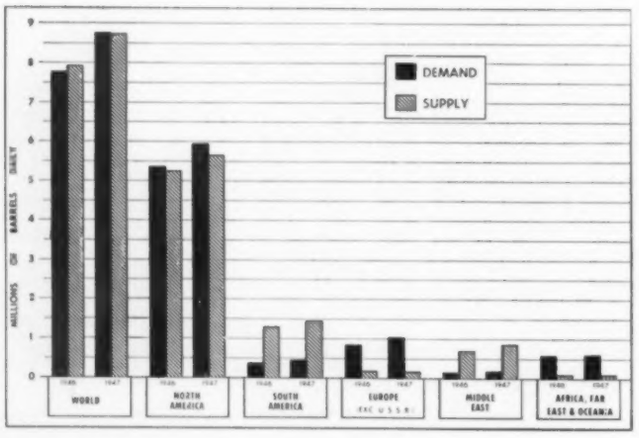
In 1810, an Englishman formed a company to compress gas into tanks and sell it. In 1870, Pintsch gas

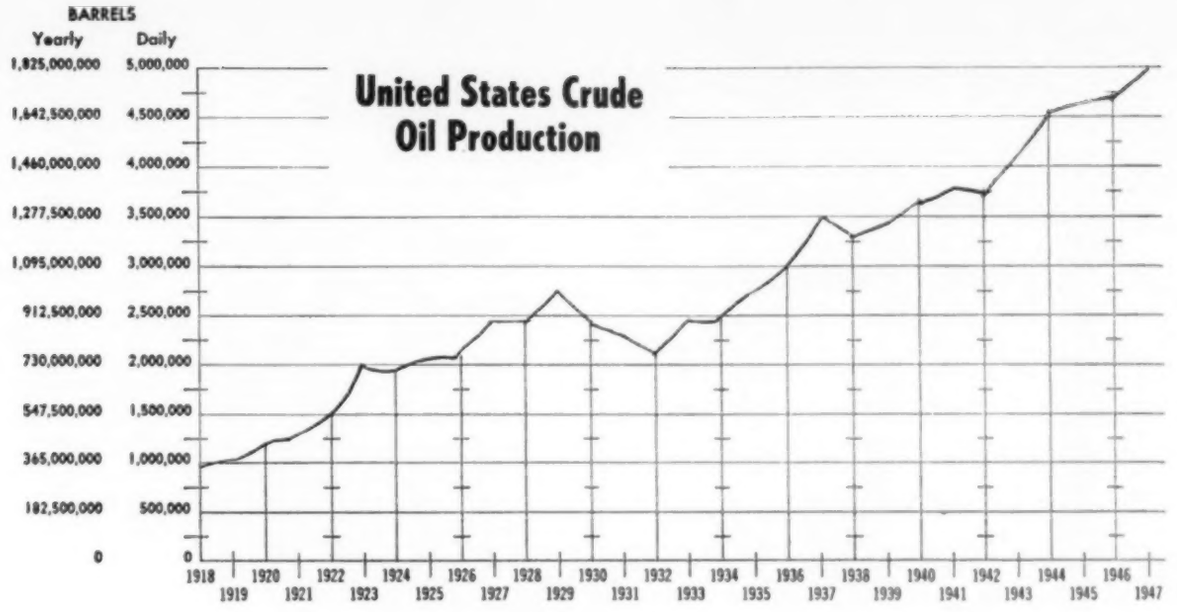
TABLE I

Properties of Propane and Butane

	Propane	Butane
1. Btu per cu ft of gas measured at 60 F, and atmospheric pressure (30 in. Hg)	2,520	3,270
2. Btu per lb of gas	21,600	21,300
3. Range of inflammability of gas in air. Per cent gas in air-gas mixture	2.4—9.5	1.8—8.4
4. Vapor pressure — psi, gage at 60 F	92	12
at 100 F	172	37
5. Lb per gallon liquid at 60 F, and storage tank pressure (vapor pressure at 60 F)	4.24	4.86
6. Specific gravity of liquid at 60 F (water equals 1.00)	0.509	0.584
7. Boiling point of liquid at atmospheric pressure	44 F	32 F
8. Cu ft of gas (60 F atmospheric pressure) per pound of liquid	8.59	6.51
9. Cu ft of gas (60 F atmospheric pressure) per gallon of liquid measured at 60 F	36.5	31.8
10. Specific gravity of gas (air equals 1.00)	1.52	2.00

Figure 3 — The chart gives the petroleum supply and demand requirements for the years 1946 and 1947.





(All Figures in Barrels)

YEAR	Yearly Total	Daily Average	YEAR	Yearly Total	Daily Average	YEAR	Yearly Total	Daily Average
1918.....	355,928,000	975,000	1928.....	901,474,000	2,469,000	1938.....	1,214,355,000	3,327,000
1919.....	378,367,000	1,037,000	1929.....	1,007,323,000	2,760,000	1939.....	1,264,962,000	3,466,000
1920.....	442,929,000	1,213,000	1930.....	898,011,000	2,460,000	1940.....	1,353,214,000	3,707,000
1921.....	472,183,000	1,294,000	1931.....	851,081,000	2,332,000	1941.....	1,402,228,000	3,842,000
1922.....	557,531,000	1,528,000	1932.....	785,159,000	2,151,000	1942.....	1,386,645,000	3,799,000
1923.....	732,407,000	2,007,000	1933.....	905,656,000	2,481,000	1943.....	1,505,613,000	4,124,900
1924.....	713,940,000	1,956,000	1934.....	908,065,000	2,488,000	1944.....	1,677,904,000	4,584,400
1925.....	763,743,000	2,092,000	1935.....	996,596,000	2,730,000	1945.....	1,713,655,000	4,694,900
1926.....	770,874,000	2,112,000	1936.....	1,099,687,000	3,013,000	1946.....	1,733,424,000	4,749,100
1927.....	901,129,000	2,469,000	1937.....	1,279,160,00	3,505,000	1947.....	1,853,166,000	5,077,100

Source: U.S. Bureau of Mines, except for latest year, which has been calculated with aid of Bureau statistics for first 10 months and American Petroleum Institute weekly reports for last two months.

Figure 4 — Crude oil production in the United States has steadily mounted throughout the years.

was made from oil and used extensively in lighting railroad cars. About 1900, Blau produced a liquid gas in Germany by cracking oil. A few years later, about 1908, several "Blau Gas" companies were formed in the United States. These, however, did not flourish and in a few years mostly disappeared.

All during this period, and from the advent of the first discovery of oil at Titusville, Pa., by Col. Edwin L. Drake in 1859 and its subsequent refining, liquefied petroleum gases were mostly a nuisance to the refiner, and much of it was burned at the flare head or otherwise wasted. Up to 1922, propane, a poor relative of the petroleum industry, seemingly had no use in gasoline, took up much valuable space in the fractionating towers, and was so heavy it created great difficulty in gas transmission lines. With those facts continually staring the refiner in the face it was an absolute necessity that propane, and in turn some butane, should be removed. The problem then arose, "Where was it to go?" Much of it, particularly propane, ended in the flare head, but some hardy, venturesome spirit built a strong, steel cylinder, compressed and liquefied the propane and/or propane-butane mixture, then bottled and used it for off-the-gas-main cooking. Thus began the liquefied petroleum gas industry.

Liquefied petroleum gas—What are liquefied petroleum gases "propane" and "butane?" As explained earlier, their source may be from natural gas or from oil refineries. Their chemical composition and characteristics are such that they have been most difficult

TABLE II

Sales of Liquefied Petroleum Gases

Year	Total gallons	Domestic	Industrial and miscellaneous	Gas manufacturing	Chemical manufacturing
1922	222,641	.....	.....	.....	.....
1928	4,523,000	2,600,000	400,000	1,600,000	.....
1937	141,400,000	40,823,000	62,610,000	11,175,000	26,792,000
1945	1,067,979,000	533,262,000	256,577,000	53,849,000	224,291,000
1946	1,415,800,000	766,000,000	255,400,000	86,600,000	307,600,000
1947	1,845,000,000	1,010,000,000	285,000,000	135,000,000	415,000,000

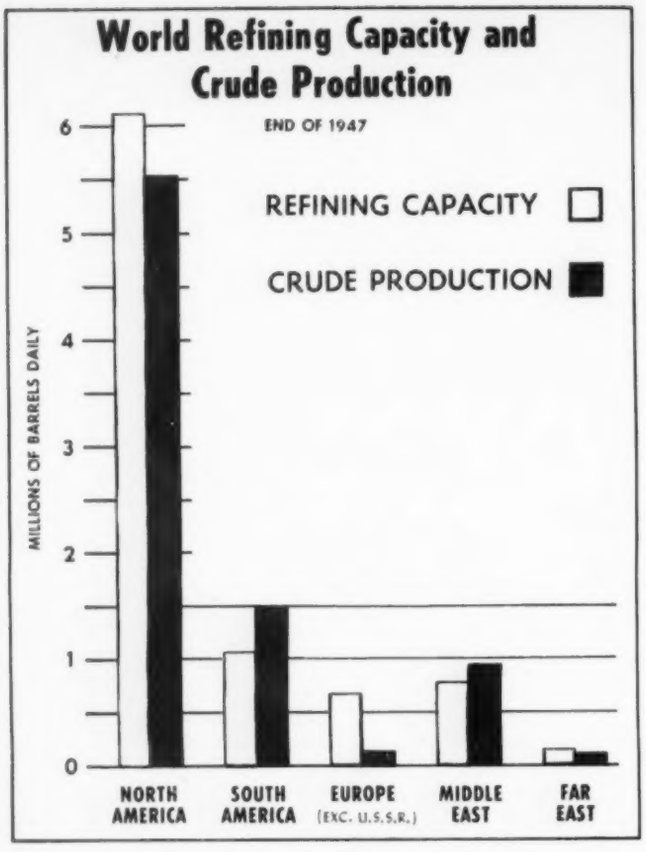


Figure 5 — In 1947 the total refining capacity in the whole world was only slightly in excess of crude oil production. For each one of the areas shown, the bar at the left is refining capacity and the bar on the right is crude oil production.

and expensive to obtain and handle until such time as a great enough demand was created to warrant the necessary expenditures. (See Table I)

In 1922, the sale of liquefied petroleum gas mixtures, according to the Bureau of Mines, amounted to 222,641 gallons. In the years following, the growth progressed steadily until World War II came along to give it abnormal impetus. (See Table II)

Part of the tremendous increase in liquefied petroleum gas sales was due to the war, for it was found that by blending butane with low-grade gasoline, a high-octane gas resulted. Butane itself has an octane rating of almost 100, so consequently makes an ideal motor and aviation fuel under certain climatic conditions and when properly blended with regular gasoline. In some sections of the country butane is used exclusively as motor fuel. The mileage per gallon is greater than with gasoline, and maintenance is cut appreciably, for operators claim decarbonizing of the cylinders is never required. Other maintenance is cut correspondingly.

Another extensive use developed since the beginning of the war has been the transformation of butane into synthetic rubber. This, of course, had been accomplished in a small way in many quarters before this country was cut off from its normal rubber supply. With the overrunning of the Malaya Peninsula by the Japanese it became necessary for the rest of the world to develop a rubber substitute in quantities and do that quickly. This the United States did and thereby, along with augmenting gasoline, used up most of the butane production until rubber began to return as an import. Now a considerable share of that butane which was formerly needed has been returned to domestic and other uses. However, it must be remembered that the value of these liquefied petroleum gases has been establishd through chemical developments. With butane it is reported that twice its volume was used for motor fuel blending in 1945 as compared to the volume of propanes, butanes and mixtures used by the whole liquefied petroleum gas industry during that same period. This butane is, of course, available to the industry if the liquefied petroleum gas consumer is willing to pay a premium over its value as motor fuel. Here, as always, the fundamental law of supply and demand enters the picture.

Propane, used in the rubber industry in the form of styrene, will undoubtedly end up in the plastics industry in great quantities as that industry becomes further developed. Here again the answer to price is supply and demand.

Per cent C_3H_8 and C_4H_{10} extracted—From refiners' reports it appears that whereas most of today's plants are in a position to reclaim 95 to 100 per cent of the butanes they still are far from effecting a 100 per cent reclamation of propanes. Due to the excessive cost of equipment required to remove the propane, some plants remove only 10 per cent, and most not over 40 per cent. This indicates that there is still available much propane at a cost, but it must be such that the propane can sell to make a return upon the investment required to extract it. Petroleum operators have estimated that 14,500,000,000 gallons per year of the butanes and propanes are probably available at refineries and gasoline and cycling plants. Of the figure just given, 9,250,000,000 gallons are available at refineries, of which plants some 480 are now in operation. With the increase in refineries taking place at the present time it is anticipated that by the end of 1948 there will be an increase of at least 1,250,000 gallons daily.

If the astronomical figures given the foregoing are anywhere near correct, and we have every reason to believe they are, then comparing the estimated production with present day use there seems to be no question as to the availability of propanes and butanes for many years to come. In fact, even today, plenty of liquefied petroleum gases are available, but transportation has been the limiting factor. As time goes on this situation will gradually correct itself.

Tank cars—Pressure tank cars available for liquefied petroleum gas service number at the present time only about 4,000. Of this number, 3,000 are of ICC-1015A construction suitable for the transportation of propane. Some 3,000 to 4,000 additional propane cars are on order by the various refiners and dealers in liquefied propane gases. However, the slowing up in steel production, coupled with other more important demands, has definitely sidetracked the putting into operation many ICC-105A cars.

Domestic—Since the beginning of time the drudgery of housework has been mostly occasioned by the fuel requirements of the home. With the introduction of manufactured, then natural gas, this drudgery has largely been reduced in the cities and larger towns through the installation of main systems for the supply

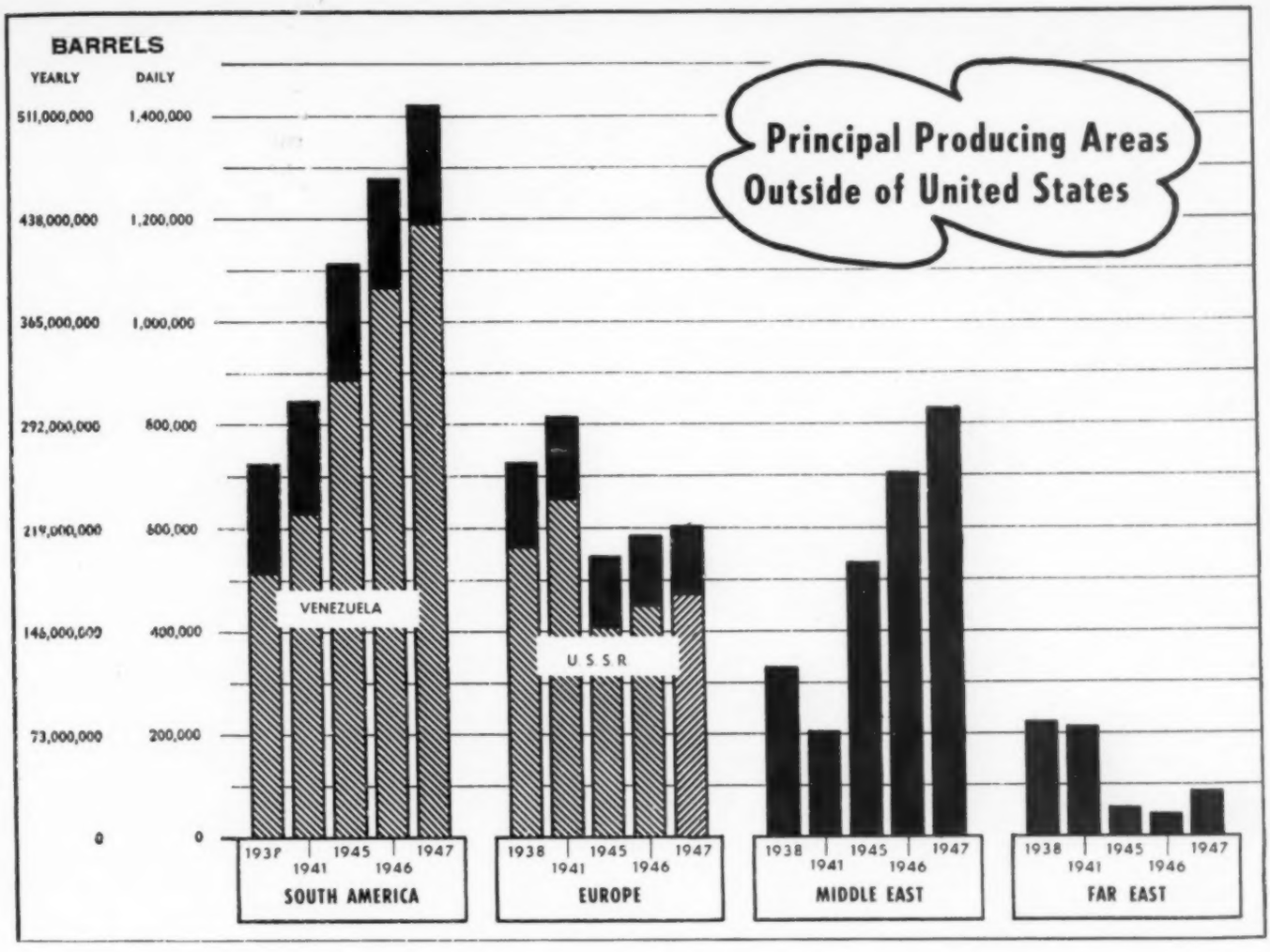


Figure 6 — The second largest oil producing area in the world is Venezuela.

of gaseous fuel. Outside of the larger communities, the housewife had, up to 1922, been confined to coal, oil and wood, two of which gave uncertain, uncontrolled heat, were dirty, and required much labor. With the introduction of liquefied petroleum gases the rural housewife was presented with luxury such as her city sister had enjoyed for years.

When it is realized that approximately one-third of our population live beyond the gas mains, and that many suburbs of cities, most villages and towns, and practically all farms in the country, lie far removed from either manufactured or natural gas, it clarifies the picture of the potential possibilities for the future domestic load.

A recent release by the Gas Appliance Manufacturers Association states that:

"Seven million, two hundred thousand new cooking customers were added from 1935 to 1947.

"Twenty-two million, nine hundred thousand homes now cook with gas, an increase of 45 per cent over 1935.

"Two million, eight hundred thousand electric range users were gained during that same period, with electric ranges now in use totaling 4,000,000."

They also state that:

"Over 90 per cent of all homes on piped gas lines use gas for cooking, and 62 per cent of all homes in the United States cook with either piped or bottled gas. Rural bottled gas customers now total 3,500,000, 600 per cent more than existed in 1935. Total liquefied petroleum gas supplied customers were estimated as 4,500,000 at the end of 1947.

"Electric range installations in rural territories total 1,785,000."

Mr. D. P. O'Keefe, president of the Gas Appliance Manufacturers Association, in another article stated that during the period 1935 to 1947, of the 7,200,000 customers added to gas cooking, 3,200,000 of them were added through liquefied petroleum gas distribution.

Since the years 1935 to 1947 embraced virtually five years of war conditions, with all kinds of restrictions imposed upon the appliance manufacturer as well as the refiner and consumer, it is not hard to visualize a runaway market for domestic liquefied petroleum gas installations as soon as ranges and water heaters, as well as propane bottles and propane, once again flow freely. One million new consumers are predicted for 1948.

Electric competition—With the above in mind, it is interesting to note the reaction of some of our electric brethren to the advancement of liquefied petroleum gas. At an electrical divisional meeting a speaker read a paper on and stressed liquefied petroleum gas com-

petition. He pointed out the fact that the industry has graduated from its swaddling clothes, is headed by responsible business men, has an active, aggressive association of its own and is out for business, and is fast eating into territory that the electric man has long considered his and his alone. He pointed out that statistics show the electric industry is losing the domestic load in small towns as well as rural communities, and that large cities are fast conforming to the same pattern.

Other uses—There are myriads of other uses for liquefied petroleum gases, particularly propane, which has a dew point of minus 44 F and is, because of that feature, usable as bottled gas the year round in most any climate except the torrid zone, although we are shipping skid tanks on the decks of vessels to Brazil and bottled gas to Singapore and Batavia. I have mentioned briefly some of the chemical uses, but besides those already mentioned there are literally hundreds of others. One of the greatest developments from this time forward, in my estimation, is going to take place in utilization of bottled gas on the farm.

Liquefied petroleum gas on the farm—Farm work, as time goes on, is going far towards offsetting the terrific winter peak now being experienced. Much development work is under way, and in addition to the household uses the agriculturist now uses liquefied petroleum gas for dairy work such as sterilization, dehydrating, flame weeding, fruit ripening, hot beds and green houses, canning, poultry raising and motor fuel. The latter is used most extensively in the far west and found to be extremely advantageous from its snappy action and lack of carbon-forming constituents, thus reducing maintenance to a minimum.

The potential of bottled gas customers is great. Consumer satisfaction is running high, and the yearly increase of installations has reached that point where a prospect no longer considers that he is experimenting when he adopts liquefied petroleum gas. A few years hence it will be a "must" in all territory removed from utility service. A normal customer will use 300 to 450 gallons a year, and since approximately one-third of the population of the United States reside beyond the gas mains it means that some 45,000,000 people (approximately 9,000,000 homes) have no recourse to the speed, pleasures, benefits and luxuries of gaseous fuel other than liquefied petroleum gases. Whereas not 100 per cent can afford or will use bottled gas, there still remain an estimated 70 per cent who can and will, thus leaving a material growth for the industry.

Natural gas augmentation—I have purposely left this phase of future use last because I firmly believe that here is a market far surpassing any hitherto considered. With long, natural gas pipe lines supplying great areas of our country there is always a peak, which means that someone must do without in whole or in part. In fact, all natural gas rates made of late years have a "cut off" clause included, which takes care of the domestic customer, the hospitals, the food producer, and then on down to the manufacturing establishment. All manufacturers are cut first in case of shortage and emergency. They may be down for a day, a week, or a month, once, twice, or perhaps many times during the heating season. This means that establishments employing thousands produce nothing during that shutdown period. Likewise, their employees earn nothing, thus cutting down the spending in that section. Many such shutdowns were necessitated the winter of 1947-48 throughout the United States from a shortage of natural gas through pipe line inadequacy. This, in time, may be remedied, but some of the leading statistics and company reports indicate otherwise.

To stress my point, may I quote from the 1947 annual report of one of the largest of the natural gas companies:

> "So great are the present demands for natural gas that the subsidiaries, in common with nearly all other natural gas companies in the nation, had insufficient supplies available during the winter of 1946-47, and substantial curtailments became necessary. An industrial curtailment of 25 per cent or more was generally in effect during the period from February 1st to April 10, 1947. Curtailments were also made in deliveries under certain wholesale contracts."
>
> (This same curtailment was experienced during the 1947-48 winter).

This report goes on to state that a purchase contract for additional gas from a large pipe line company has been restricted because the pipe line company has been unable to secure adequate pipe, hence "will not be able to deliver the maximum quantities of gas provided by their contracts for more than a year. For this reason, the present short supply of gas may continue through next winter, depending, of course, upon the demand for natural gas." This system, along with many others, is attempting to restrict further additional house heating sales, and they say, "Even if such restrictions on sales are enforced, current operating estimates show that there will probably be deficiencies in the supply of gas during the coming winter." During the winter, 1948-49, that particular system will be augmenting its supply with Texas as well as liquefied petroleum gases. Several propane-air augmentation plants have been erected in the Pittsburgh area, two in Ohio, and a very large one near Detroit, and still curtailment is the rule of the day throughout the country with the pipe line officials talking that with present day consumption it will be at least five years before they can remedy the condition.

Legislation—It sometimes seems as though the average individual of our country does not realize the value of natural gas or, in fact, gaseous fuel of all kinds to industry. If they did, they would not permit public representatives to act as small town constables, bludgeoning the purveyor of the greatest boon to mankind until he is unable to move. The Natural Gas Act was ten years old on June 21, 1948. Originally, it required a Certificate of Public Convenience and Necessity for a proposed pipe line only if projected market was already served by another natural gas company. In 1940 the Federal Power Commission recommended an extension of a Certificate of Authority over all construction. This extension was granted as of February 7, 1942, which immediately denied all rights granted to the natural gas companies, by the original act, to enlarge facilities for the purpose of supplying increased market demands in territory in which the company already operated.

This year there appeared the Rizley-Moore bill (Representative Rizley and Senator Moore of Oklahoma). The purpose of this bill was to clarify rather

than alter in any fundamental way the original intent of the present Natural Gas Act and to define more clearly the status of producers, gatherers and distributors, as well as to set up standards to be followed by the Commission. This bill finally, before adjournment of Congress, was pigeonholed and lost. Senator Moore charged in a Senate speech on June 17th that "a well planned and well executed propaganda program of the red element in the United States under the leadership of Leland Olds of the Federal Power Commission" was responsible for the defeat of the bill.

The senator pointed out that the Rizley-Moore bill was intended to prevent further extension of the Federal Power Commission under Mr. Olds' sponsorship in the continuation of a campaign which already "has almost terminated the building of further interstate pipe lines from the southwestern gas fields to the consuming areas of the north and east."

The senator stated that Mr. Olds has filed a report with the Interstate and Foreign Commerce Committee of the Senate and testified that he (Mr. Olds) believes the gas reserves of the southwest should be locked up and that the population of the north and east should be forced to move to the southwest as a matter of social advancement in order to use these gas reserves for industrial purposes. He has made the statement that he does not believe natural gas should be permitted to be competitive with coal and oil. He has also stated that as a step in managed economy in this country the Commission should determine when, where and for what purpose natural gas may be used.

Natural gas substitution—All the foregoing means that with pipe lines curtailing from 25 to 75 and sometimes 100 per cent from December through March, industry, to remain in business, must have a substitute for natural gas.

What better substitute is there than propane-air of from 1,300 to 1,400 Btu, depending upon the natural gas composition? Here is a gas interchangeable with natural gas without so much as an air shutter adjustment. A great many propane-air plants are being installed by industry, and as their value becomes realized more fully many more will be contracted for before the next heating season rolls around.

Natural gas augmentation is a field for liquefied petroleum gas use that has not had the surface scratched. After the experience gleaned during the past few winters and as soon as the manufacturers, municipalities and pipe line companies really awaken to the wonderful possibilities of liquefied petroleum gas substitution, as well as the true state of the natural gas position, there will not be enough propane-air plants to go around in the time available before the following heating season.

Plants installed the past few years have saved many hours of wages for the employees and dollars profit for the employer.

It may sound strange to you to hear a representative of the liquefied petroleum gas industry ask just why should industry be penalized every winter because of gas shortage. This penalty is annually visited not only upon industry but upon the employees who, by that annual denial, are deprived of from a few days to sometimes weeks of livelihood.

The next best procedure is for industry to prepare for eventualities so that when a shortage does occur they can continue uninterruptedly, thus saving for themselves lost time which never can be regained, as well as profits and, best of all, keep their employees at work.

Responsibility of the steel industry—An industry such as the steel industry has a tremendous responsibility upon its shoulders with a 1947 payroll of $1,990,000,000. Of this amount, four-fifths went to wage earners. This sum represents $1,600,000,000 which, when divided by 52 weeks, means a weekly earner's wage of $30,800,000. AISI reports show that during 1947 the average number of wage earners employed was 526,000. Simple division shows that the average wage earner takes home each week $58.50.

The greater percentage of the above sum was paid out in the central states, which area includes Illinois, Indiana, Iowa, Michigan, Ohio, Minnesota and Wisconsin. The second most important area is that of the middle east. This section comprises principally Pennsylvania, New York and New Jersey, with some smaller amounts going to Maryland, West Virginia, Delaware and the District of Columbia.

The Financial World (New York) had this to say in bold type regarding 1946:

> "Wages and salaries paid by the iron and steel industry and its principal customers accounted for 39.2 per cent of the payrolls of all manufacturing industries in 1946. The calculation just released by the American Iron and Steel Institute shows payments of $14,100,000,000 to workers in the steel and steel fabricating industries against $36,000,000,000 paid to workers in all industries.
>
> "The lead was taken by the central states of Illinois, Indiana, Iowa, Michigan, Ohio, Minnesota and Wisconsin, which paid out $7,000,000,000 during the year. The middle eastern states accounted for $4,000,000,000, while New England trailed in third place with $1,300,000,000. Bottom place in the tabulation was held by the northwestern states with $130,000,000."

Wages—This is but a repetition of the figures given by the Institute but without "steel" the world would go back to the age of primitive man. It is by far the most important, powerful and far-reaching industry of the present age and generation. It is important, therefore, that every corner be cut, leading towards greater production and efficiency. With labor averaging $1.51 per hour during 1947 and rising to $1.55 average in 1948, plus the fact that the hours per week in 1948 have increased to 40.6 as against 38.2 for 1947, it behooves the industry to use every legitimate method possible to keep the wheels turning constantly with no shutdowns. Based upon the first part of 1948 operations the total payroll and salaries for the year will closely approach an increase of $250,000 over those paid during the year 1947.

Losses—In figuring time losses, we can neglect salaries for they go on whether or not the plant shuts down from lack of gas, except that with too many cutoffs production begins to lag, profits go down, and eventually that loss catches up with the salaried employee and stockholder, as well as the wage earner. The wage earner, however, feels the effect immediately. During

that shutdown period the few carefully hoarded savings are soon dissipated. Food and clothing budgets must be cut, which directly reacts upon the business of the merchants of the community.

A $30,800,000 per week loss in wages means that with a shutdown of five weeks the industry not only loses production with continuing overhead and interest charges, but builds up increased maintenance, thus reducing profits and at the same time causing a loss of $154,000,000 to the wage earner and the various community merchants.

It would seem that an industry with a total investment of $4,490,459,402 in 1946, and a net income of $264,419,213, could ill afford not to prepare 100 per cent by an additional investment of $100,000 for the larger plants and $50,000 or so for the smaller. This additional investment would save many times that amount each and every year. The great American curse is, "Let's gamble." Many plants are doing so and regularly sustaining appreciable losses thereby. The last few years, however, industry as a whole has begun to wake up, and why more have not done so during 1948 is a mystery. Some companies represented here have taken the "bull by the horns" and prepared, so that they no longer need suffer these losses.

A survey made by Iron Age reported on 1,350 metal working plants as to whether their gas-fired furnaces had been hampered by gas shortages and how many would consider standby equipment. (Metal producing plants not included.) Of the 1,350 plants reporting, 62 per cent used gas furnaces, and of that number 41 per cent were affected by gas shortage. This covered the entire 48 states, many of which have no sizeable metal working establishments. The worst affected states were Alabama first, with 83 per cent of the plants affected, Ohio second with 80 per cent, and West Virginia third with 66 per cent. Of the 836 plants (62 per cent using gas furnaces, 42 per cent indicated a desire for standby equipment, and only 19 per cent had such.

The irony of this survey was in the answer to the question, "Would you consider it profitable to invest any of the following sums for standby conversion equipment?" Only 199 of the 345 plants affected by gas shortage answered that question, and they stated as follows:

88 would consider	$ 5,000
49 would consider	10,000
18 would consider	15,000
16 would consider	20,000
28 would consider	25,000
199	

Forty-eight metal producing plants answered the same question with the following results:

6 would consider	$ 5,000
5 would consider	10,000
3 would consider	15,000
3 would consider	20,000
31 would consider	25,000
48	

A plant having to invest $25,000 for standby conversion would only need a saving of $3,750 during the winter shutdown period to pay a handsome 15 per cent return upon its investment, or, with a saving of $5,000 there is a 20 per cent return. Either of those returns makes a good investment no matter in what part of the U.S.A., and the probabilities are that not one of the metal working or producing plants would, in any winter, have lesser percentage savings than those quoted.

An industry using 224,419,000,000 cu ft of natural gas can ill afford not to have protection, as many plants (some of them steel) have found out to their benefit.

SAVINGS EFFECTED BY PROPANE INSTALLATIONS

Plant "A"—In New York State, a plant employing 25,000 and manufacturing nationally known electrical equipment, invested $100,000 in a propane plant in 1947. The plant was hardly in operation before it was called upon to assume 100 per cent of the load for 15 days. Then for two days it ran 75 per cent. Several more days ran 50 per cent, and the remainder of three weeks gas was off 25 per cent. At the end of that time it went back on 100 per cent manufactured gas.

The management stated that the first four hours of operation the first day paid for the plant investment.

The wage rate at this plant is $1.50 per hour, so that without standby the employee loss of wages and the loss to the merchants of the city would have been not less than $1,800,000 for the first 15 days of 100 per cent cutoff. This is assuming that only about 10,000 of the 25,000 employees would have been affected. The total payroll savings to the employees and merchants for the entire period amount to not less than $2,280,000. The savings of this company, since they operate around the clock, amounted to $1,500,000 per day.

Plant "B"—Another smaller branch of the same company located in Ohio and employing 800 came out with a statement in its employee publication as follows:

> *"Liquid gas installation prevents plant shutdown during cold wave.* Loss to employees of more than five weeks' earnings saved by standby facilities."

They further state:

> "Employees have received six pay checks that would have been lost to them otherwise, and the company has been able to maintain an almost normal schedule of production of products still in critical short supply. Not only was the continued supply of motor parts assured but production processes such as atmosphere annealing were uninterrupted."

This company carries 30 days supply of propane, and after some experimentation with different Btu's found they could do a better job of wire annealing than they could with natural gas. In neither of the two companies quoted was there a change of burners or any adjustments necessary except for gas torches. These required some experimentation in Plant "A." The investment required in Plant "B" was but $21,000 since they employ several hundred persons. Here again, as in Plant "A," the plant paid for itself many times over during the cutoffs, to say nothing of the keeping up of the production schedule and the payroll savings to employees.

Plant "C"—A third plant of the same group as "A" and "B", employing 3,000, invested $57,000. They were able to keep going for from five to six weeks when otherwise they would have been shut down because of gas shortage. The engineer of this plant made the state-

ment also that certain annealing operations had improved so greatly under propane operation that he was continuing them the year round notwithstanding the higher Mcf and therm cost.

Plant "D"—Another big, chain, electrical plant in Ohio has had a propane plant for several years at a cost of about $42,000. Two years ago it operated for five weeks and kept 3,500 employees going who otherwise would have been out of work and pay. During the 1947-48 winter this plant operated for 50 days, keeping up full production as well as payroll.

Plant "E"—A large metal working plant in Ohio employing 700 spent $100,000 for standby. They would have been down for five weeks without propane augmentation and substitution.

All of the foregoing plants work 24 hours per day and have sizeable payrolls. In every case, the proper Btu was delivered in the substitute gas so that one day natural gas might be in the mains to the furnaces, and the next day propane-air gas, with no untoward effect or adjustment of burners required. These plants are only a very few scattered throughout the country which are successfully combating gas shortage and delivering goods on schedule irrespective of what happens to the natural gas delivery.

Strikes—As if natural gas shortage was not enough of a harassment, strikes may interfere with operations. Propane cannot run steel plants, but it can keep ovens hot if no natural gas is available, and it can thus keep heats up to whatever temperature is desired so that in a few hours time heats can be back to normal and your plant in full operation when the strike is settled. Heats kept up on a battery of ovens during only one strike will more than pay for a standby plant. An oven costs $6,000 to $8,000 to reline, and on top of weeks required for relining there are additional weeks needed for letting down and starting up. All of the foregoing adds up to months of time.

Now, I want to answer several questions:

First, as to cost of propane plants, the answer is that can be determined only by a careful investigation as to:

a. Type of operation.
b. Fuel and quantity consumed.
c. Btu of present gas.
d. Likely period of standby.
e. Maximum hours consumption.
f. Type of soil for foundations.
g. Space available for plant and proximity to siding.

Secondly, my statement that 95 to 100 per cent of butanes are today being extracted while only 40 per cent of propanes at most may bring up some questions. Also, if the petroleum refinery reserve last year was but 7 per cent in excess of production, how are we going to get the production to care for increased demand? The answer is, of course, supply and demand. If the demand is present, the refineries will be and, in fact, are being built all over the world. This also applies to natural gasoline-extracting plants on the natural gas lines and in the fields. As to cost, propanes and butanes will follow crude oil. About 2 per cent of the oil refined comes out as liquefied petroleum gases, all depending upon demand as to how much of it is flared and how much is extracted. Wet natural gas, the other source for liquefied petroleum gas, varies widely, depending upon its characteristics. The American Gas Association gives a fair figure of 3 gallons per Mcf of gas processed, divided as follows:

Propane	1.5 gallons
Iso-butane	0.5 gallons
Normal butane	1.5 gallons

The publication of the Standard Oil Co. of New Jersey, "The Lamp," had some interesting figures on refinery costs some time ago. I will quote them here:

"A refinery today costs $1,500 per barrel of capacity as compared with $500 per barrel 20 years ago."

They also tell me that those plants now recovering a portion of their propanes to increase to 90 per cent would require additional investment of from 1 to 2 per cent of the total refinery cost. Translating that into understandable figures, it would mean that a 10,000-barrel-a-day refinery costing $15,000,000 would need an additional investment of from $150,000 to $300,000 to recover propanes. At the present time many plants are increasing their capacities for propane extraction up to 60 and 65 per cent.

DISCUSSION

PRESENTED BY

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FRANCIS E. DRAKE, Vice President and Chief Engineer, Pacific Gas Corp., New York, N. Y.

Walter N. Flanagan: Mr. Drake has indicated that butane or propane (liquefied petroleum gases) are in general a desirable emergency or standby fuel for industrial plants. This indication will, I believe, be accepted by all concerned, provided that the cost and availability are equal to or better than that of competitive fuels.

Petroleum fuels (oil and natural gas) are only about 1 per cent of the total mineral fuel resources of the U.S.A.—oil being roughly one-half per cent and natural gas one-half per cent. Coal, including lignite, forms 99 per cent of the reserves. Oil and gas, (due to deeper wells required to reach new supplies and longer transportation distances, are becoming more expensive in spite of noteworthy developments by the petroleum industry.

Under certain conditions, not now realized, coal and its products can provide all necessary make-up fuel for the steel industry. While high-flame temperature

gaseous fuels are ideal for most metallurgical uses in the steel industry, liquid fuels (oil and tar) are highly desirable for both regular and emergency use in open hearth furnaces. The position of fuel oil must be analyzed as long as petroleum products are available. Fuel oil is only a small fraction of the one-half per cent of liquid petroleum and is rapidly becoming a smaller fraction due to the development of new refining processes.

As indicated by Mr. Drake, the demand far exceeds the supply of petroleum products. Therefore, the steel industry, which forms one of the largest, if not the largest) customers of the petroleum industry, must turn to coal as it did in the beginning. In later years, the steel industry, except for coking coals, has tended to abandon coal as a metallurgical fuel. In the interests of smoke and dust prevention, increased tonnage and quality control, the industry has turned to gaseous and liquid fuels.

Today an integrated steel works can be so built as to require no outside metallurgical fuel. Its coke works and blast furnace by-products can actually supply all fuel and power requirements. However, under present construction costs it is questionable whether such a plant can be justified. Therefore, we are back again to the problem of emergency and/or substitute fuels in existing plants.

Table I illustrates the fuel balance of a fully integrated steel works producing a practically complete range of rolled steel products.

The plant illustrated is representative of modern but not 100 per cent new facilities. Inspection of line 18 of Table I indicates a deficit of 14,800 units of high flame temperature fuel which represents 38 per cent of the open hearth fuel requirements. Tar (if not otherwise utilized) is available for 22 per cent. Thus, the practice in most plants would be to purchase the 14,880 units as fuel oil to give 38 + 22 = 60 per cent, or the desirable minimum percentage of liquid fuel. Tar is too valuable a source of coal chemicals to be used freely as a fuel, except under emergency conditions.

A higher percentage of gaseous fuel can be used but much development is ahead if loss of production rate is to be prevented in many plants. The elimination of sulphur from gaseous fuels greatly increases their range of application.

Inspection of lines 10 and 12 indicates a deficit of power and miscellaneous fuels which can readily be met by coal of ordinary steam quality.

While it is difficult to compare standby fuels with regular operating fuels, and there is no question but that peak and emergency fuel is worth something over commonly available Btu, the following comparison, Table II, tends to indicate the high price of butane and propane against presently available fuel oil and possible utilization of coal.

The comparison shows that, from both the investment cost and the operating cost (including the fuel), oil, as long as available and usable, is much less expensive than liquefied petroleum gases. Likewise, if a continuous fuel deficit exists, various methods of utilizing coal can be installed, ranging from synthesized oil to ordinary coal producer gas.

As the primary open hearth fuel, oil is worth in most

TABLE I

Fuel Balance
Integrated Steel Works
Producing Complete Range of Rolled Steel Products
All Fuels Expressed in Millions of Btu per 24 Hours

By-product fuel and heat available	
1. Blast furnace gas produced	100,000
2. Coke oven gas produced	57,200
3. Tar produced	8,600
4. Coke breeze	16,200
5. Open hearth waste heat	13,700
	195,700
Blast furnace gas — Primary uses	
6. Blast furnace leakage	2,000
7. Blast furnace stoves	19,000
8. Blast furnace blowing	12,000
9. Coke oven underfiring	23,700
Sub-total	56,700
10. Surplus blast furnace gas	43,300
Coke oven gas and tar — Primary uses	
11. Coke oven underfiring	2,620
12. Open hearth	38,900
13. Soaking pits	13,100
14. Heating furnaces and finishing operations	22,950
15. Miscellaneous	3,110
16. Sub-total	80,680
17. Coke oven gas and tar produced	65,800
18. Deficit in high flame temperature fuels — (represents 38 per cent of open hearth fuel)	14,880
Other fuels required	
19. Plant steam fuel requirements	28,300
20. Fuel for electric power	39,550
21. Coke breeze to soaking pits	1,850
22. Total ordinary uses for blast furnace gas, coal or coke breeze	69,700

plants (per Btu) about 1½ times 500-Btu coke oven or synthetic coal gas and probably 1¼ times butane or propane. Therefore, while apparently more expensive than liquefied petroleum gas, synthesized oil is more desirable as a basic fuel. Oil storage capacity is relatively inexpensive in comparison with any form of gas storage.

Gases may be utilized to advantage and at full Btu value as a secondary portion of the open hearth fuel and for all other processes.

Coal producer gas, while lowest in investment and operating cost, has the disadvantages of lowering open hearth production and of increasing operating costs. It also requires the use of high grade coal when used to supplant tar or oil. The tendency of producer gas to reduce open hearth production rate may possibly be overcome by the use of oxygen at the furnace ports or in the producers.

However, radiant characteristics are valuable in open hearth fuel, and the addition of oxygen does not necessarily improve flame characteristics—only flame temperature.

Many other coal applications are available, ranging from the installation of additional by-product coke oven capacity to produce tar and coke oven gas and the utilization of the coke to make water gas—through various applications of oxygen to reduce fuel requirements—down to the simple use of powdered coal in the open hearth.

TABLE II

Comparison of Fuel Costs

Line	Fuel	Calorific value in Btu/unit	Cost per unit	Cost per Mm Btu	Operating cost additional	Investment per Mm Btu
1	Butane and propane	21,600/lb	$0.0254/lb	$1.17	$0.005	$5.00 to $26.00
2	Fuel oil (heavy)	150,000/gal	$0.11/gal	0.73	0.050	0.27 to 0.67
	The following are based on continuous operations.					
						Investment per Mm Btu annual capacity
3	Synthetic oil from coal	150,000/gal	0.20/gal	1.34	0.050	$3.30
4	Synthetic gas from coal	500/cu ft	0.375/cu ft	0.75	See Note	1.50
5	Ordinary coal, producer gas (hot)	165/cu ft	.....	0.50	See Note	0.20
6	Same as Item 5 enriched with oxygen	.....	.....	0.60	.....	0.70

NOTE: Capacities on Line 1 — 30,000 to 300,000 gal. Fuel cost from Platts Oilgram.
Fuels indicated on Lines 1, 4 and 5 may cause loss of open hearth production rate.
Lines 2 and 3 are acceptable basic open hearth fuels, if low in sulphur.
Line 6 — Producer gas introduces dust, soot and allied problems.
Costs are based on steelworks size plants in non-restricted areas.

In general, liquefied petroleum gases are a desirable but expensive emergency fuel for many processes. However, the steelworks' greatest fuel problem is the supplanting of open hearth oil and tar economically and without loss of productive capacity. In view of the great reserves of ordinary quality of coal—not good enough for coking or conventional producer use—the long-range answer appears to be coal synthesis.

Much literature has been published on this subject, and some research is under way. In view of the magnitude and urgency of the problem you will note that the word some is used to qualify research.

J. B. Wagstaff: I would like to make some comments on Mr. Flanagan's very interesting comparison of fuel costs. In his table, Table II, he has compared both the operational costs and the capital investment required to make synthetic oil and gas from coal. These costs would seem extremely high, and I wonder whether Mr. Flanagan is fully aware of the recent research being carried on in the oil industry aimed at reducing these very costs.

It is now possible to make synthetic oil for 11.4 cents per gallon with an investment of only $2.10 per million Btu annual capacity as compared with the figures of 20 cents per gallon and $3.30 per million Btu annual capacity given by Mr. Flanagan. Similarly the cost of making synthetic gas has also been cut in half and a cost of 16½ cents per thousand cu ft of gas of 460 Btu per cu ft is possible with an investment of only $0.82 per million Btu annual capacity. Naturally these figures will vary somewhat with the type of coal used, and they are sensitive to the cost of raw coal. There is, therefore, a great advantage in locating plants of this character near to the coal source and transporting the products by pipeline where possible.

A. M. Thurston: Referring to Table I and II in Mr. Flanagan's discussion, oil is given as 73 cents against $1.17 for butane; probably No. 5 or No. 6 oil is referred to. If No. 1, No. 2, or No. 3 oils, which are the usual standby oil fuels, are considered, the cost has been nearly a standoff with propane for the past year or more considering fuel cost above.

On refined operations such as annealing, atmosphere gas, etc., the relatively high investment cost in standby plant is really an insurance against process interruption and is a justified investment.

We have ten propane standby plants at factories in the East Ohio Gas Co. territory, and we have every reason to believe that each of those companies considers their investment well worth while.

C. W. Hatch: Liquefied petroleum gases, for some uses and under favorable conditions, make a very desirable fuel. As fuel for cooking, water heating, etc., in rural communities where piped gas is not available, it is, because of its cleanliness and convenience, becoming very popular as bottled gas. For similar uses in small towns where the installation of a gas works could not be justified, distribution of a gas-air mixture from a central storage and mixing station could well be considered provided the inhabitants are sufficiently prosperous to pay the price for the convenience. There also seems to be, as stated by Mr. Drake, a considerable potential market for various uses on farms. The extent to which the above markets may be developed depends on the willingness and ability of the prospective customers to pay the price, which at the present time is high in comparison with other fuels and the assurance that deliveries will be made when needed. It would be ill advised to promote the sale of this fuel at a rate greater than the increase in facilities for delivery.

For industrial use there are probably some cases of small plants which require gaseous fuel but which for various reasons may find it advantageous to locate where piped gas is not available. In such cases, liquefied petroleum gases are a solution to the problem. There are other cases where industrial plants normally de-

pending on natural gas find it necessary to provide a stand-by fuel to insure continuity of operations during periods of gas curtailment. As liquefied petroleum gas-air mixtures can be made which are interchangeable with natural gas without any change in combustion equipment, this fuel is well adapted for such a standby. Sufficient storage space, well isolated from buildings, must be provided to supply the seasons requirements. The amount to be carried in storage may be reduced if the requirements are sufficiently well known so that a definite schedule of deliveries may be set up, but it must be remembered that at the present time transportation facilities are not sufficient to meet emergency requirements. Very careful engineering, from the safety angle, is required. The gas is dry and hard to hold, it is heavier than air so that if any leak occurs it is not rapidly diffused into the atmosphere as is the case with lighter gases, the lower limit of inflammability is low, a concentration of only 2.5 per cent of gas in air being inflammable.

With regard to the steel industry and with particular reference to fully integrated steelworks, liquefied petroleum gases may, under some conditions, and for some purposes, be of considerable value but cannot be considered "The Perfect Fuel." The integrated steelworks served with by-product coke ovens has available a very valuable fuel in coke oven gas which may be used for all heating operations from soaking pits to finishing mills and to a considerable extent for heat treating. In general the supply is not sufficient to meet all of the possible requirements and coke ovens are not operated as gas works with the production of gas maintained at a rate to suit demand. Reduced output may occur at the time of peak demand or the output may increase with a lower demand. In order to hold the waste of coke oven gas to a minimum, it is desirable to provide sufficient equipment to burn this gas at its maximum rate of production which, of course, requires the use of an auxiliary fuel to carry over the periods of low production. Also, as previously stated, some additional fuel will be needed to meet the requirements of all heating and heat treating operations. Gas producers may be used but they do not provide sufficient flexibility to be ideal. Fuel oil, except for cost, is better suited to the requirements but if natural gas is available it meets the situation almost to perfection. Natural gas, because of its cleanliness and freedom from sulphur is preferable to coke oven gas for heat treating.

If natural gas is available this gas might well be used for all heat treating operations while the soaking pits and reheating furnaces could be fired with coke oven gas, any deficiency being made up by the introduction of a mixture of natural gas and air into the coke oven gas mains. This can be made of the proper heating value and density to replace coke oven gas without change in equipment. Such a setup is conceivable as long as natural gas is available but is not workable if the natural gas supply is subject to curtailment, as it is at the present time, unless some auxiliary fuel is available. Liquefied petroleum gases are worth consideration for this purpose. For the heat treating operations a gas-air mixture might be substituted for natural gas quickly and easily without any changes to equipment. This would compensate for some reduction in supply. For greater reductions the solution is not so easy. A mixture of liquefied petroleum gas and air which can be used to replace coke oven gas without changes to equipment cannot be made. However, if natural gas is not entirely cut off it seems possible that the gas-air mixture as prepared to displace natural gas might be mixed with natural gas in proportion of possible 20 per cent gas-air mixture to 80 per cent natural gas and this mixed gas then diluted with air to give a final mixture which could be used in the coke oven gas mains.

Any contemplated installation to provide liquefied petroleum gas as an auxiliary fuel must receive individual and careful consideration. It may be desirable in some cases and entirely impractical or impossible in others. Sufficient space, isolated from mill buildings and from adjacent property which is, or may be built upon, must be available for storage. Assurance must be obtained that local authorities will allow the installation. The seasons requirements must be determined and sufficient storage provided to meet those requirements or assurances obtained that additional supplies may be secured when required. In this connection it might be mentioned that the supply of natural gas to the east is being increased as rapidly as steel can be obtained for pipe lines and that the liquefied petroleum gas industry is in much the same position in regard to inadequate transportation facilities as the natural gas industry, with the added handicap of long railroad haul. Justification of the cost of installation and the high cost of the fuel will require careful study for each individual case. The safety feature must be considered. With this heavy gas having a very low limit of concentration in air to form an inflammable mixture the importance of guarding against even small leaks cannot be over emphasized.

Mr. Drake mentioned the use of liquefied petroleum gas as a fuel to maintain coke oven temperature during strikes. A few years ago our company considered such an installation. It was found that in our case to provide sufficient storage to hold the required oven temperature for a ten-day period would require sixteen 30,000 gal tanks, the largest permissible size. This required a considerable area which could only be made available by taking space which it is contemplated to use for future plant extension. The total cost including equipment, foundations, installation, railroad spur, etc., would have been in excess of $500,000.00. As this sacrifice of valuable space and expenditure of a half million dollars would only provide protection for a ten-day period and as in the past no strike had occurred during periods when natural gas was not available, it was decided not to proceed with the installation. We also heard that during this heating up of the coke ovens at Fontana, Calif., with liquefied petroleum gases a serious explosion was experienced. Possibly Mr. Drake can give some particulars concerning this as to what was done wrong or left undone. Such information would be of value to any one contemplating the use of liquefied petroleum gases.

Martin J. Conway: We are indebted to Mr. Drake for the presentation of a paper in which he had dealt chiefly with the small users of gas, as measured in terms of steel industry gas usage. Some plants we are acquainted with use from 10,000,000 to 15,000,000 cu ft of natural gas daily and, as described by Mr. Drake, have been

shut off from their gaseous fuel supply for several days at a time during severe winter weather.

These steel plants would require much larger liquefied petroleum gas storage than most of the plants referred to by Mr. Drake. In round figures, it requires 11,000 gallons of propane storage to equal 1,000,000 cu ft of 1,000 Btu natural gas. Therefore, for a fourteen-day standby storage of propane to rpelace 10,000,000 cu ft of natural gas daily, it would be necessary to provide liquid storage for 1,540,000 gallons of propane. In addition, the propane Btu replacement cost may equal three times the natural gas cost, which is certainly little inducement to provide standby storage unless shutdown losses are excessive and a switchover to fuel oil cannot be made to bridge the gap.

Mr. Drake is courageous in his reporting on some of the interference existing to discourage the necessary extension of pipe lines from the natural gas fields to the industrial centers of the country. True, most of these industrial centers are close to coal deposits, but in the long range program for our national fuel distribution, it may be possible that the existence of these gas distribution lines will be a boon to the local coal industry in that synthesis gas, made from coal, can be supplied to these trunk distribution lines, if and when the natural gas supply diminishes.

I noted that Mr. Drake omitted stating another advantage of liquefied petroleum gases; that of replacing acetylene for gas cutting, which in some of the small plants may result in sufficient saving to pay for the standby storage.

Personally, I agree with Mr. Drake's observation that it is the function of the public utility supplying the gaseous fuel to also provide sufficient standby storage to insure continuous operation.

Francis E. Drake: Regarding Mr. Flanagan's figures, I am not going to take exception to any of them. There is no question but that propane and butane costs more per million Btu than oil. The answer is the volume obtainable and how it can be used efficiently.

One thing about propane, you do not have to worry about sulphur, another it is 100 per cent efficient. In other words, you use a gallon and you have a full gallon available as Btu. Of course, you are going to get some loss in the summertime due to radiation causing vaporization. That loss, however, depends upon the setting of the safety valves on the tanks and the leakage therefrom.

Now another point regarding Mr. Flanagan's statements. I would like to stress that propane and butane air plants are in many cases more insurance than anything else. We all of us pay many, many dollars for insurance which we hope is never going to be used, but many times is required. Insurance is needed in the steel industry as it is in every other industry.

Mr. Hatch, I believe, made a statement regarding possibilities of explosion and inflammability of liquefied petroleum gas as compared to other gases. I am a gas man and have been all my business career. I was brought up on smoke shoveling, in the retort house and all that. I cannot understand why gas men shy at liquefied petroleum gas when they just eat coal and other gases. They swallow them whole and call them good.

The explosive limits of liquefied petroleum gas are about 2.8 to 10, whereas with coal gas, water gas and natural gas they run from 3 or thereabouts up to 30, and sometimes higher. Blue gas runs up to 60.

Where is the difference, except that liquefied petroleum gas is heavy? It does stay down near the floor. That is the reason we try to put our plants out in the open where the wind will dissipate the gases readily.

In all liquefied petroleum gas construction there is a rule book that we follow. This is the National Board of Fire Underwriters 58. If that book is followed there is no more danger with liquefied petroleum gas than there is with coke oven, water or any other gas.

I know nothing about an explosion at Fontana that was referred to. I do know that at Ogden, Utah, the ovens were brought to heat with liquefied petroleum gas. They put a plant in especially to do that, because there was nothing else available.

There was no trouble. I have been told there was little if any interchange of finger bars or any other changes when they substituted coal gas when it was finally produced.

At Fontana, my understanding has been that the plant also was brought up to heat and that liquefied petroleum gas has been used at various times without any great variety of oven adjustments.

I know that at Waukegan, Ill., just outside of Chicago, there was a test run made some years ago on coke ovens, when they needed the oven gas for purposes other than under firing. They used propane and butane in various percentages and it worked perfectly.

Mr. Flanagan asked about liquefied petroleum gas restocking. In the last couple of years conditions have been extremely difficult for the liquefied petroleum gas man because of the number of standby plants which have been erected and the demand for fuel during the worst part of the year, when transportation was next to impossible. Tank cars have been limited. Last year we had an order in for some 200-odd cars and received 25. Everybody else obtained the same proportion. This consequently left propane tank cars in a precarious position. Today contracts can be signed on a two-for-one basis. In other words, if you take two cars in the summer you can obtain one car in the winter. Conditions are gradually working around so that you can receive your propane requirements as needed.

As we all know, supply and demand will prevail. This past summer we burned in Texas at the flarehead a great many tank cars of propane that we would have liked to have sold. Everybody else has done the same. That gives you, the customer, distress fuel. Some of that fuel has been sold at a discount, because it is sometimes better to sell at 50 per cent rather than lose 100 per cent. Thus, if you have adequate tankage you can perhaps make an extra dollar by buying in the summer and storing it for winter.

In one instance which I spoke of previously in my paper there was substitution for oven gas. This was in New York State, where interchangeable propane air-gas was substituted for coke oven gas. This coke oven gas was 540 Btu, which is the New York State standard. We substituted 880 Btu propane air-gas, and it went over 100 per cent, except for a few torches on which they had to change spuds. There were only about a dozen of these. All of the heat treating ovens and every other piece of equipment went on 100 per cent with no trouble at all. This plant operated off and on for 5 weeks during the winter of 1947-48 without change of orifices or air shutters.

OXYGEN IN STEEL

. . . . further experience with the use of oxygen in steelmaking indicates that it may be more economical to use smaller flows and quantities than that used in the earlier development work . . . .

▲ DURING recent years a great deal has been published on the subject of oxygen in the open hearth and electric furnaces, yet little of this information can be applied directly to the conditions in any one mill. Most of the work has been done in large steel mill furnaces where the makeup of the charge varies from furnace to furnace and from shop to shop, but lately there has been an expanding interest in the small electric furnace. As more experience has been gained, many of the problems incident to the accelerated production resulting from the use of oxygen have assumed greater significance, with the result that certain members of the steel industry are now studying the subject objectively.

We will summarize briefly some of the general conclusions that we have drawn from thousands of heats made under a wide variety of conditions. We will describe some of the apparatus that has evolved from this experience. Oxygen has been used in two ways: for combustion during meltdown and occasionally during refining in the open hearth; and for decarburization in both the open hearth and electric furnace.

USE DURING MELTDOWN

A wide variety of burners were used. It was found there was definite improvement in heat transfer to the cold charge when the oxygen stream was directed below the stream of atomized oil. This placed the oxygen at a point where the increase in the intensity of the flame would be most effective, directly above the scrap and in an area farthest from the roof. It was learned when using oxygen, that the best results were obtained when the firing rate was increased. Obviously, oxygen permits burning more fuel in a given space. At the outset, oxygen flow was started at the beginning of the charge. This frequently resulted in scrap beginning to melt before the furnace bottom had reached a temperature high enough to keep the metal in a molten state. The result was refreezing of the metal, or at best a low bath temperature, foamy slag, and longer refining time. Today we think there is sufficient evidence to indicate that if oxygen is used after the charge has reached a temperature of approximately 2000 F, and is continued until the charge has completely melted, oxygen will have produced the best overall result.

As conditions under which oxygen could be best applied became better known, attention was directed toward the economics of the process. In the experimental work, oxygen of varying purity was used from so-called high purity of 99.5 per cent down to approximately 21 per cent (atmospheric air). As purity was decreased, there was a gradual decrease in effectiveness. Studies were made to learn the effect of preheating the air and applying it in exactly the same manner as high-purity oxygen. These studies are continuing in several large shops. Results to date indicate that combustion improves as the temperature of the air is raised, counteracting the loss in efficiency due to the lower oxygen content. It was found that by directing a high-velocity stream of air below the oil stream at a temperature somewhere between 600 and 700 F, production rates and fuel consumption per ton of steel produced were comparable to the results obtained with high-purity oxygen.

It has been evident that as the atomization of the oil improved, furnace efficiency increased. Improved atomization has been accomplished by the use of double burners mounted one above the other, the upper burner supplying 40 per cent of the total fuel input and the lower burner supplying the remaining 60 per cent with the oxygen or preheated air stream entering below the lower burner.

We believe considerable progress can yet be made in the field of combustion as applied to the conditions existing in an open hearth furnace. The foregoing is presented to indicate where the trend seems to be directed, that is, the use of preheated compressed air and double burners.

OXYGEN FOR DECARBURIZATION

Oxygen injection into the molten bath is of interest to both the open hearth and electric furnace operators.

The principal advantages of oxygen injection into the open hearth bath are:

1. Acceleration of carbon elimination.
2. Increasing the bath temperature.
3. Speeding the start of the lime boil (in basic furnaces).

Oxygen injection accelerates carbon elimination by agitating the bath and by supplying a source of oxygen to react with the carbon.

When ore is used a considerable mass of cold material is added to the bath that has to be heated by contact with the molten metal and slag. The amount of heat required to raise ore to the bath temperature and decompose it is approximately 9500 Btu per pound of oxygen released. Since this heat is abstracted from the steel bath and must be replaced from the burners (in the open hearth) at very low thermal efficiency, for every pound of oxygen contributed by ore 9500 Btu multiplied by a factor of 2 or 3 are needed to maintain bath temperature. Coupled with the fact that the FeO-C reaction is endothermic at steel making temperatures, the result is a lowering of the bath temperature, or at best, a reduction in the rate of temperature rise. When oxygen is used in place of ore for decarburization, no great mass robs heat from the bath, and the

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PRODUCING FURNACES

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overall reaction of oxygen with iron and the resulting iron oxide with carbon is exothermic. Furthermore, when oxygen is used, the reaction rate is increased, which in turn raises bath temperatures, as heat losses by radiation are reduced. A considerable increase in bath temperature is therefore realized.

In basic open hearths it is possible to start a lime boil by injecting oxygen into the bath over the pile of lime. The localized heating and agitation of the bath starts a lime boil which will then proceed with no further assistance from the oxygen.

The theoretical amount of oxygen to remove 1 point of carbon per ton of metal is 3.2 cu ft. However, the atmosphere of an open hearth furnace will supply oxygen to the bath via the slag and the actual consumption of added oxygen is therefore somewhat lower and on the order of 2.5 cu ft per ton point.

In electric furnaces, producing carbon and low alloy steels the advantages of oxygen injection into the bath are similar to those mentioned for open hearth furnaces. The actual amount of oxygen necessary to remove a ton point of carbon is, however, higher than the theoretical figure since the furnace conditions are not nearly so oxidizing as in an open hearth furnace.

When oxygen is used for decarburization of stainless steel in large electric furnaces, certain advantages have been noted, according to J. H. Eisaman, superintendent, No. 2 electric furnace, Carnegie-Illinois Steel Corp., Chicago, Ill. "Use of Oxygen for Decarburization and Melting in Electric Furnaces," paper delivered before General Meeting of American Iron and Steel Institute, New York, May 26-27, 1948:

1. "High percentage of stainless steel scrap may be used.
2. "High percentage of recovery of chromium from the scrap can be obtained.
3. "Kwhr per ton are lowered since the oxygen-chromium reaction is exothermic, thus providing additional heat.
4. "Tons per hour are increased.
5. "Material handling costs are lowered, since no ore is required, and since there is less waste slag to be handled.
6. "Due to the high residual chromium in the bath, less offheats because of chromium content occur, since errors in either weighing or sampling of the bath are relatively of less importance when adding chromium to a bath with a 12 per cent residual to meet an 18 per cent specification than with a low residual chromium bath.
7. "Less off-quality heats occur in the straight chromium grades. These grades are subject to conditions known as "back up" or gaseous ingots, which result in large rejections. This condition is brought about by the metal, as tapped, containing excessive amounts of gases, the worst of which is believed to be hydrogen. If a good oxygen blow is used, the gas content of the bath is lowered. The back up condition has not been observed at south works in heats which have had normal carbon reduction with oxygen."

For the past year there has been increasing interest in the use of oxygen for decarburization in small electric furnaces. Although no great amount of data is available, nevertheless, it is evident that oxygen has some very attractive possibilities for the operators of these furnaces. It appears possible to increase production without large expenditures for capital equipment. The fact that oxygen can replace iron ore to a large extent, makes it attractive to electric furnace operators in areas where the price of iron ore is high. However, a great many small electric furnaces are geared to foundry operation and need no increase in production, and they also may be in areas where the price of ore is not out of line. In these cases oxygen can still offer some important advantages. Obtaining a lower Kwhr consumption per ton, decreased electrode consumption and greater alloy recovery are features that will interest any electric furnace operator regardless of geographical location or type of product.

At this point, it might be appropriate to add a word about some of the means that have been employed in injecting oxygen or air in the bath. Two main methods have been used, the first employing a conventional type oxygen lance consisting of a piece of pipe of suitable length. The lance is inserted through the door of the furnace into the slag and the gas impinges approximately at the interface between the slag and the molten metal. This method obviously has the advantage of being simple to set up. However, it has a distinct disadvantage in that its continued use obstructs the normal activity on the charging floor. It also requires manpower with the attendant difficulties that accompany any application where the human element is involved. In an attempt to eliminate some of these difficulties, we have developed a non-consumable water-cooled jet device which can be operated either through the door of the furnace on the charging side, or can be mechanized and inserted through the back wall of the furnace. With this latter type of installation, all objectionable hoses are removed from the charging floor, and complete mechanization is possible. Work is under way on this latter development to reduce the amount of splash encountered when employing the lance or the single outlet jet and the results look extremely promising.

A disadvantage of the use of oxygen injection, particularly in the open hearth furnace, is the volume of fumes developed, particularly when operating in the higher carbon ranges. This smoke problem is not serious when the use of oxygen or air for carbon reduction is confined to the lower carbon ranges.

DISCUSSION

PRESENTED BY

F. M. GEIGEL, Assistant Superintendent Open Hearth, Ford Motor Co., Dearborn, Mich.

G. D. STONE, The Linde Air Products Co., Chicago, Ill.

D. PETER, Open Hearth Department, Ford Motor Co., Dearborn, Mich.

HARRY W. CLARK, Metallurgical Engineer, Ford Motor Co., Dearborn, Mich.

M. J. SMITH, Assistant Superintendent Open Hearth, Ford Motor Co., Dearborn, Mich.

E. PATRICK, Superintendent of Open Hearth, Ford Motor Co., Dearborn, Mich.

J. E. McDERMOTT, The Linde Air Products Co., Chicago, Ill.

F. M. Geigel: What is the effect of injection of oxygen on the roof life?

G. D. Stone: I think it has been pretty generally found that at the excessively high rate of flows of oxygen that were used at the beginning of these experiments two years ago, there was a very definite effect on roof life, by reason of the fact that they were using a large volume of oxygen, 30,000-40,000 cfhr. You had a very short and intensely hot flame and the heat was reflected to a spot on the roof directly above the flame. With the smaller volumes that we feel should be used, and I am speaking of furnaces with a capacity of 100 or 125 tons, flows of 15-20,000 cfhr—there need be no serious effect on the roof. On carbon reduction, however, in the ranges above 30 carbon, there is quite a serious effect on the roof. In the lower carbon ranges, however, 30 carbon and below, I think it can be said that there is a good possibility that your roof life may be increased by reason of the fact that you get this heat out of the furnace faster. Also, you know what happens when you are trying to make 10 carbon or less, sometimes the heat has to lie in there for several hours, and it is not doing the roof any good.

D. Peter: Has there been any research at all done along the line of possibly injecting a few different jets at the same time, and in what way cutting down reflectivity on one concentrated spot, and therefore equalizing wear on the roof and deoxidizing in a shorter length of time?

G. D. Stone: There is some work under way now on using more than one jet and work has been done with more than one lance. However, I think that the damage to the roof is the direct result of the rate of reaction on the higher carbon levels rather than putting the oxygen in at more than one point. I think there probably will be slightly less damage to the roof in a given spot by applying your oxygen at more than one point, but I think it is still true, you will find, that the damage is considerable no matter how many points are used to put it in. Also I believe it is more a question of carbon range than the number of points of impingement.

Harry W. Clark: In 100- and 125-ton furnaces, you say you would use 15 to 20,000 cfhr of oxygen. What would your recommendation on oxygen be on a furnace of 150 to 200 tons using high volume or low volume?

G. D. Stone: I would say the length of the furnace would have something to do with it regardless of the capacity; it is a question of the length of the flame. If your flame is too short, regardless of how much oxygen you are using, the tendency is to melt the scrap at a very rapid rate at the incoming end of the furnace, and it is apt to freeze up at the other end. What we found in using preheated compressed air, indicated an advantage because we seem to get a very sharp flame which extends over the entire bath, and the rate of melting is almost as high at the outgoing end. Therefore, it is hard to say that you should use 30,000 cfhr in a 200-ton furnace or 35,000 or 25,000 cfhr. Some of those furnaces are extremely long, and also the type of burner has something to do with results. I would say, however, the less oxygen you can use and still get the desired flame is the right answer. I cannot be more specific, as there are a number of variable factors that make it difficult to give a specific answer.

M. J. Smith: We at Ford's have been doing some work with oxygen on the bottom, that is, draining holes in the bottom. Is anybody else doing this that you know of?

J. E. McDermott: Yes, oxygen has been and is being used for bottom and bank repairs in those shops that have oxygen piped up to their furnaces. The shops using oxygen in place of compressed air find that oxygen does a better and a faster job of rabbling and cutting drains.

E. Patrick: Are oxygen injections effective in removal of sulphur?

G. D. Stone: There have been some claims that the use of oxygen for decarburization have resulted in the reduction of sulphur. I believe that the Inland Steel Company thought they saw that effect. We are inclined to feel, however, that if there is any effect on the sulphur, it is by the addition of heat as the result of the reaction of the oxygen and the carbon, the lime goes into solution much more rapidly and any effect on the sulphur is because of that factor.

J. E. McDermott: No claim is made that oxygen removes sulphur directly; however, indirectly oxygen does aid in sulphur removal by being very effective in shaping up the slag and putting limestone in solution.

One of the mills, where considerable lancing is practiced, has found it possible to cut the limestone charge to about one-half without experiencing sulphur troubles.

A second mill producing strip steel has experienced sulphur removal in the low carbon range on the heats lanced with oxygen. When high residual sulphur is encountered, it is their practice to add one or two boxes of raw limestone immediately preceding the lancing operation.

After about a thirty minutes lancing operation, the average time required to meet the carbon specification, considerable sulphur will have been removed. In most cases enough sulphur has been removed to meet the specifications and no delay experienced in tapping the heat.

Application of Electronics

IN THE IRON AND STEEL INDUSTRY

. . . . electronic devices have long since been developed from the laboratory stage, and many ingenious designs, especially developed for steel mill use, are finding wide-spread acceptance . . . .

By W. M. McKIE
and
D. A. LAMONT
Canadian General Electric Co., Ltd.
Ontario, Canada

▲ WHEN the second World War began, the application of electronics to industry was already ten years old. Since then, the staggering demands made on industry have forced manufacturers to operate with little or no margin of spare capacity and to expand their plant facilities as rapidly as materials became available.

Electronic control is one of several important tools for the steel engineer to use in boosting output and reducing cost. It is nothing more than a tool. In itself, it is not the push button plant of tomorrow nor the cure for production men's occupational diseases. On the other hand, it is nothing less than a tool. Its worth to industry has been proved over and over and today electronics takes its definite place in making very appreciable savings in material and labor and in improving the quality of the product in the bargain.

The advice of nine or ten years ago is still good today. Electronics is applicable to industry to fulfill either of only two requirements. Just as there should be no hesitation about utilizing it to the full in either of these, there should also be no consideration of its use whenever it falls outside these requirements:

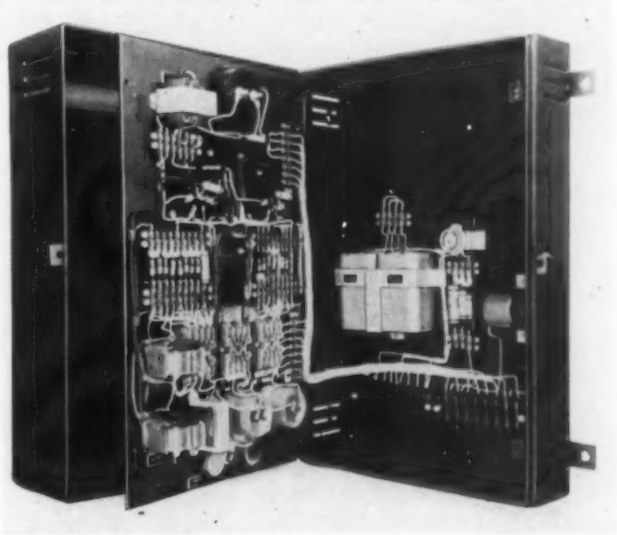
1. It should be used, naturally, where it operates in a way for which no other suitable equipment is available.
2. It should be used where its superior response, speed and sensitivity is required over that of more traditional equipment, or where its cost and complexity for an equal job is less.

The finest piece of industrial electronic equipment in the world is useless if it is not properly applied. The engineer applying it cannot know too many details about the associated gear and the requirements of the overall process. There is no advantage in using an induction flow brightener equipment on an electrolytic tinning line so that the line can be speeded up if the remainder of the installed equipment is already working at its maximum speed and capacity. Proper application and co-ordination of electronic control automatically means increased tonnage, better quality, or reduced costs, or a combination of these.

The wise manufacturer of electronic equipment knows that industrial electronic equipment must differ from the more traditional communication type of electronic equipment from its very inception in the design engineer's mind. The two cannot be confused. An entirely different approach to industrial electronic equipment is necessary to achieve the desired results. It is imperative that the designer has thoroughly investigated the circuits being applied so that performance will be as good as expected.

The varying characteristics of some tubes of the same type as made by the same or by different manufacturers must be divorced from the overall characteristics of the circuit. The tendency is to rely less on the characteristics of the tubes and more on those of the other circuit components. This means greater use of single purpose tubes and probably more tubes per equipment. Recently more rugged, longer lived counterparts of the simpler types of communications tubes have been made available for industrial applications. In addition, today's equipment is ultra-conservative in its choice of other circuit components. (Figure 1).

Figure 1 — "Industrial" type electronic wiring is more rugged than the laboratory counterparts.



Presented before AISE Buffalo District Section Meeting, April 13, 1948]

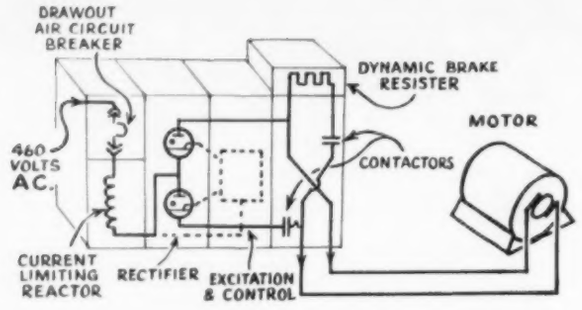
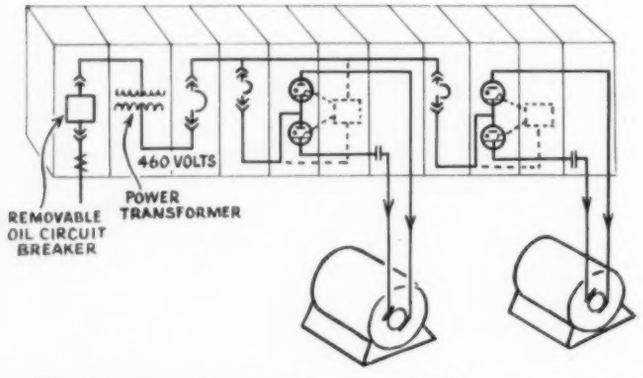


Figure 2 — Typical electronic motor control for a single motor with dynamic braking.

Figure 3 — Two separate motor controls with a common supply.



To the user, the manufacturers' adherence to these policies can only mean increased assurance of dependability in equipment which has already proven itself. A look at the photo-electric limit switch, the photo-electric pyrometer, automatic screwdown control, the flying shear, side register control, loop control, and the pin-hole detector is convincing.

New laboratory-tested electronic equipment which has had little or no field experience, and new applications of existing equipment proved in other industries, are being proven on the job by progressive user concerns. Such pioneering is essential and will inevitably continue to increase our living standards tomorrow as it is doing today.

Because it is more valuable to plant operational success, industrial electronics deserve and demand, not a greater quantity but a higher quality of maintenance attention. If users place themselves in a position to do proper maintenance, then they have the opportunity of capitalizing on the relatively new developments.

It is the intention to describe briefly some of the equipments which have come into being during the past few years.

ELECTRONIC MOTOR CONTROL

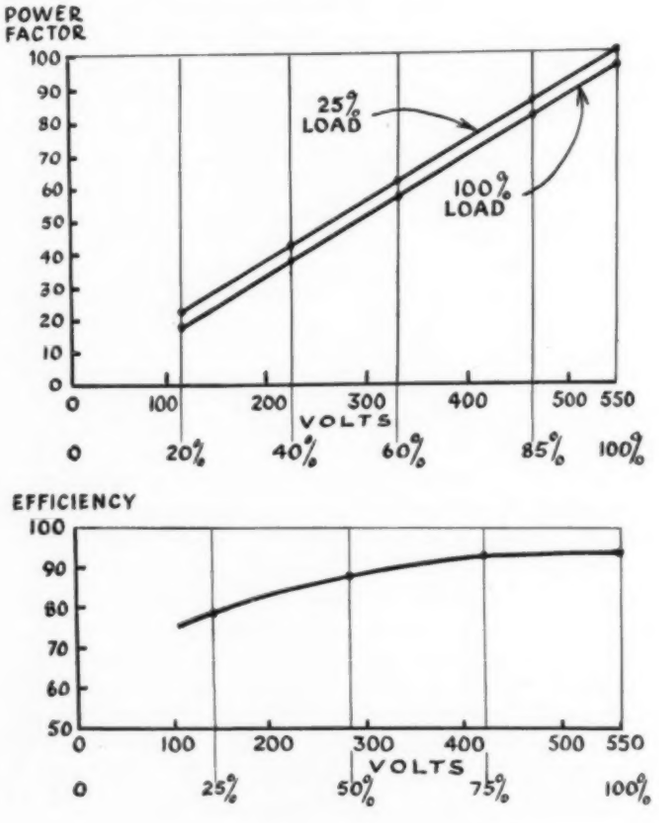
Certainly not the least of these applications is the use of controlled rectifier tubes with d-c motors to obtain adjustable speed drives where alternating current is the only power available. The inherent ability of direct-current motors to allow a greater variety of speed-torque characteristics and greater ease of control is well known. Their use, however, has been limited by the necessity of providing rotating conversion equipment for operation from a-c sources. Now, the development of efficient sealed-ignitron rectifiers and sensitive control auxiliaries makes the use of these motors far more attractive.

The equipments have characteristics similar to those of the conventional adjustable voltage system but are not adapted for rapid reversal. Two or more motors may be connected to a single electronic d-c drive unit if means are provided to isolate the individual motors and also provided they are to operate in tandem.

The heart of the unit is the six-tube double-way rectifier circuit which converts 3-phase, 460-v, a-c, to 550 v, d-c. The d-c voltage is continuously adjustable by phase controlling the ignitor excitation of the ignitrons. Any one of three sizes of tubes is used to cover the 100 to 600 hp range of drives. With a supply of 460 v, no rectifier transformer is required, although a 3-phase air-core current limiting reactor is needed to protect the ignitrons from excessive fault currents. When the supply is between 480 and 575 v, an auto-transformer is used to supply 460 v to the rectifier. With supplies of medium (2300 to 4600 v) voltage or high (up to 15 kv) voltage, a standard 3-phase power transformer may be used. Sufficient reactance for rectifier protection may be inherent in the transformer so that current-limiting reactors are usually unnecessary (Figure 2 and 3).

The rectifier output wave-form is the same as that of a 6-phase circuit so that standard d-c motors are used without the derating for increased motor heating and decreased commutating capacity necessary when d-c

Figure 4 — Power factor and efficiency plotted against voltage for electronic motor controls. Curves apply to all ratings 100 to 600 hp.



motors are operated from single phase supply. The ripple magnitude increases somewhat with reduction in voltage by phase control.

The excitation equipment provides current impulses to the tube ignitors to start the arc in such ignitron at the proper instant and in sequence. It is also the means of shifting the instant at which the impulses occur (phase control), thereby adjusting and regulating the rectifier output voltage in accordance with the dictates of a magnetically-saturable phase shift network. The excitation equipment and phase shift network consist entirely of static devices, resistors, reactors, capacitors, etc.

To provide control for starting, accelerating and decelerating the drive motor by automatically adjusting the saturating current to the excitation system, several circuits are available, but all are functionally similar. The rotating regulator is the most usual. By automatic control of the various rotating regulator fields, speed adjustment, speed regulation to one to two per cent by IR drop compensation and current limit acceleration are all provided.

The thyratron rectifier field supply automatically maintains motor field current at a constant but adjustable value. It may be advantageous for closer speed regulation by its action of minimizing the field heating effect. Armature voltage take-over control can be used to limit armature voltage when speed is rapidly lowered from a condition of weak field operation. The field rectifier controls the rate of field current increase in response to a signal obtained from armature voltage. This feature is necessary for high-inertia loads because the power rectifier will not accept regenerated power and the armature voltage might reach dangerous values if the field were strengthened rapidly before the load could lower the motor speed.

When rapid retardation is required, a dynamic braking resistor and a contactor are employed to absorb the motor's regenerated energy.

In choosing the motor base speed and the horsepower rating for a given drive, reasoning as for an adjustable voltage system applies except for the important fact that a rectifier operating at a reduced (phase-shifted) voltage has a reduced power factor. Therefore, in some instances when a constant torque (armature control only) rating may be indicated, the need or desire for higher efficiency and power factor may make it worth while to use a larger motor frame and operate in the field control range except for jogging or threading which will be at reduced voltage (Figure 4).

Reversing drive equipments are possible by arranging for the field connections to be reversed by contactors or by the alternative connection of a duplicate rectifying equipment with its own excitation and control gear.

ELECTRONIC POWER CONVERSION

The two 10,000-kw electronic frequency changers at the Edgar Thomson Works of the Carnegie-Illinois Steel Corp. have been in service since the beginning of 1944. The equipment was built around pentode sealed type ignitrons which have a 3-year warranty. Surely a

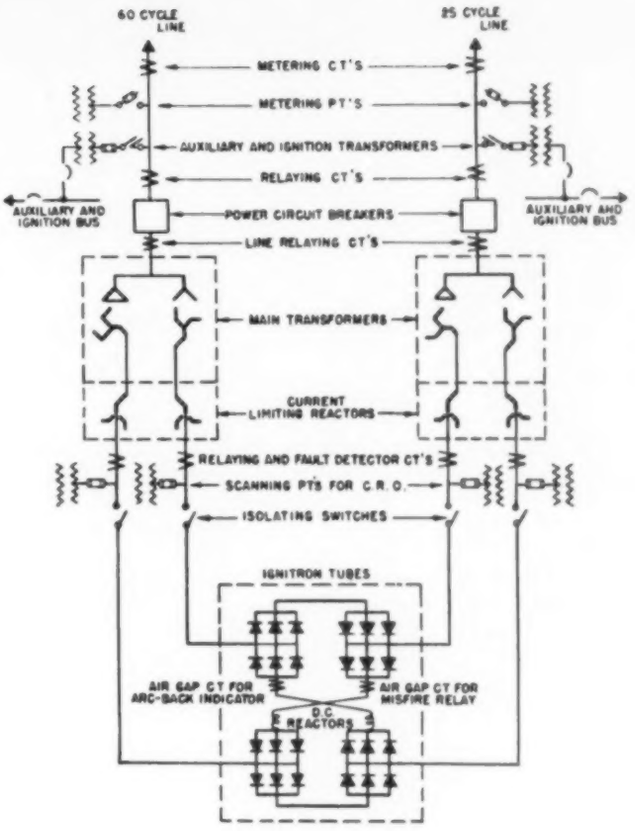


Figure 5 — Typical single-line diagram of an electronic frequency changer.

tribute to the dependability of all modern industrial electronic equipment is reflected by the fact that even after a fourth years service, over 60 per cent of the original tubes were still functioning correctly. Even basing decisions on a three-year life, the higher efficiency over the whole operating range of the electronic frequency changer compared to rotating converters, more than pays for tube renewals.

In common with other industrial electronic equipment, the electronic frequency changer has its definite sphere of application in controlling power flow between systems having the same or different steady or variable frequencies and voltages. Two conditions must exist to enable the user to reap the benefits of the simple, accurate, automatic control and the high efficiency of the electronic equipment:

1. Sufficient reactive kva needed for commutation, harmonics and transformer magnetizing current available from synchronous machinery of both of the interconnected systems.
2. System voltages sufficiently high to require the transformers necessary in the electronic changer, for insulation between a-c and d-c circuits. For cases outside this sphere, conventional equipment should be chosen.

Controls can be provided which are responsive to a number of variables, such as constant power output to one system from the other; power output from either system in response to predetermined ratios of power supplied by other prime sources of either system; etc. The direction and magnitude of power flow is controlled by varying the rectifier and inverter grid excita-

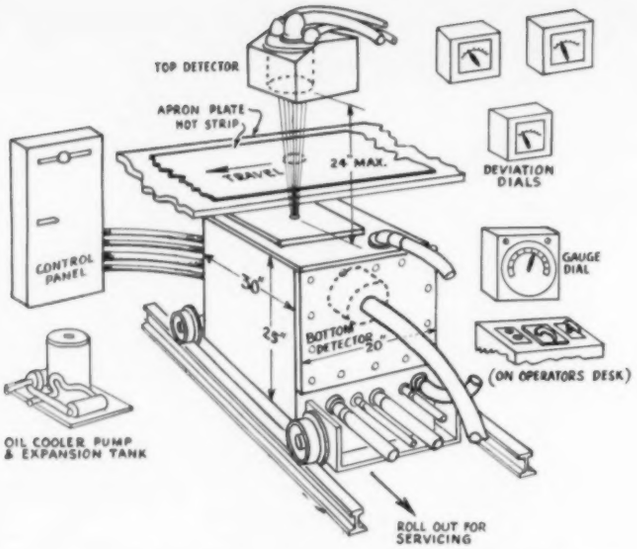


Figure 6 — X-ray thickness gages for hot strip mills help speed and increase production on such mills.

tion by the well known phase-shift method. See Figure 5.

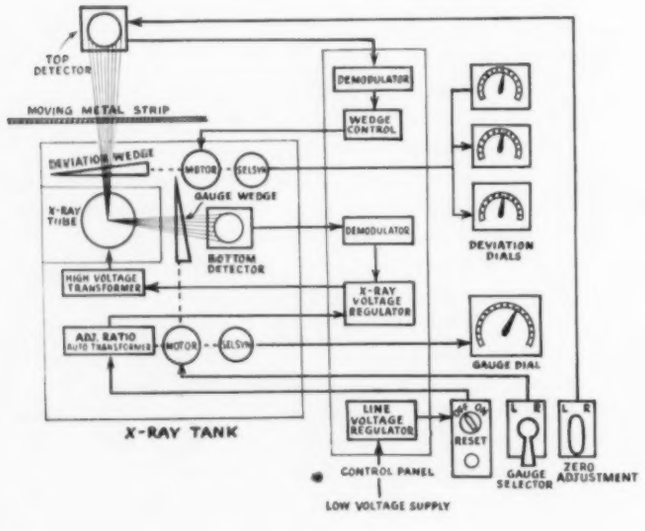
Restriction of both external and internal faults is another important benefit derived from use of the electronic frequency changer. No fault current can be contributed by the converter to a fault in the system supplying the rectifier end of the converter (pump-back), and fault current from the converter to a fault in the system being supplied from the inverter end of the converter, is limited by the inverter commutation characteristic to slightly more than full load current. For a plant whose circuit breakers would have inadequate interrupting capacity should a rotating converter be installed; the selection of the correspondingly rated electronic converter holds the possibility of using the existing breakers, other considerations being acceptable. Internal faults in the electronic converter, such as arc-backs in the rectifiers and the failure of an inverter grid to resume control (shoot-through) during positive half cycles, would cause high current in the rectifier circuits and the system supplying the rectifiers, if it were not for the high-speed relays and contactors which act quickly to bias the rectifier grids, reducing the rectifier currents to zero before they have a chance to become large. This arc suppression is immediately removed allowing the tubes to operate again all without disconnecting the converter, unless the fault remains in which case the defective circuit is locked out.

It should be emphasized that the electronic converter is a non-synchronous equipment, and as such has the further advantage of minimizing the effect of large load fluctuation of one system upon the other.

The electronic power converter may quite easily become the answer to that as yet, not commercially accepted and approved, d-c transmission system, primarily by lengthening the d-c link of the equipment described above.

More recently other important industrial electronic developments have been placed in service and are proving themselves money-savers to their users.

Figure 7 — Block diagram of X-ray thickness gage.



X-RAY THICKNESS GAGE

Probably the most spectacular of the electronic devices newly applied to the steel industry is the X-ray tube for measuring the thickness of steel strip. The first installation was made in the Irvin works of the Carnegie-Illinois Steel Corp. where it is operating on a hot strip mill.

The equipment was primarily designed to measure accurately the thickness of hot rolled strip while it is being rolled, but it is readily adaptable to solve other gaging problems where a non-contacting gage is required.

The X-ray thickness gage also has a definite application in cold strip mills where the ordinary contact type of gaging has a lower accuracy due to contact bounce at the relatively high speeds.

Prior to the advent of the X-ray gage, all gaging of the hot strip thickness had to be done at one end of the strip coil using a hand micrometer and then only after the metal had cooled considerably. A modern mill may roll something like 6 tons of steel before gaging is possible, so heavy losses due to reallocation because of off-gage strip could be expected. It is imperative that the strip thickness be gaged continuously, and near the center of its width, as it issues from the finishing stand. In addition to the difficulties from strip speeds of 2000 fpm or more and temperatures of 1300 to 1750 F, the vertical vibration of several inches as the strip leaves the rolls necessitates large clearance to avoid jamming or "cobbles." Then there is the hardship of cooling water sprays which deluge nearby equipment as well as the strip.

The X-ray thickness gage, as built, has an overall accuracy of plus or minus 2 per cent over the range of 40 mils to 190 mils of steel thickness. It is fortunate that most of the common alloying elements in steel have an X-ray absorption close to that of iron. However, silicon steels may require up to 7 per cent correction factor. Because of this, and the effects of possible impurities or changes in the steel composition, the water layer on the surface and the contraction as the

steel cools, a simple zero adjustment is provided. In addition, gages to be used for measuring different alloys have several concentric scales.

The equipment comprises several main parts: the X-ray tank unit, the top detector head, the control cabinet, the gage dial, and at least one deviation dial (Figure 6).

The X-ray tank unit houses the X-ray tube and its high voltage and filament voltage supplies in a lead-lined bath of force-circulated oil. Tungsten is used for the tube target. A 100-kv tube is used for hot steel and a 50-kv tube for cold steel or aluminum.

When X-rays strike the steel strip, a portion is transmitted through the sheet unchanged, while the remainder is either re-radiated as scattered X-rays or is absorbed within the sheet. Equal amounts will be transmitted if beams from a single X-ray tube pass through sheets of the same material having the same thickness. How this theory is put into practice is described below:

The X-ray tube transmits two beams at right angles. The horizontal or reference beam passes through a steel wedge (gage wedge) which can be moved back and forth to place a desired thickness of steel in the path of the beam. It is moved by a small reversible motor which is controlled from the operator's desk. This switch is closed by the operator until a gage dial indicates in equally spaced markings of thousandths of an inch the strip thickness that is to be held (Figure 7).

The beam passing through the gage wedge falls on a radiation detector which consists of a phototube with a fluorescent coating and a glow discharge lamp. During half cycles when the X-ray target is positive and X-rays are emitted, those which are transmitted through the gage wedge cause the zinc sulphide coating opposite the cathode of the phototube to glow. The phototube responds to this glow. During the other half cycles, this phototube responds to light obtained from the glow discharge lamp. The peak values of these two sources of light are compared and any difference which exists causes a sensitive automatic regulating system to adjust the high voltage to the X-ray tube. As the operator changes the position of the gage wedge, this regulator adjusts the penetration of the X-rays to maintain constant energy at the fluorescent coating.

The other beam passes vertically upward through a second movable steel wedge (deviation wedge) and through the thickness of the strip to be measured. In so doing, it makes a trace one inch wide on the moving strip. That which is transmitted through both the deviation wedge and the strip falls upon a second radiation detector which is mounted in a separate housing about twenty-four in. above the top of the lower unit. Again, the output of this detector is a comparison between the beam intensity and a standard reference intensity established within the detector by its glow discharge lamp. Any difference causes an automatic positioning system to reposition the deviation wedge until the difference is zero. The position of this wedge is therefore always a function of the strip thickness. The wedge position is translated electrically into an indication of the difference in mils between actual strip thickness and desired strip thickness.

Certainly an important design factor is the safety to personnel which is afforded by the measuring beam being small and of low energy. Protection against overexposure is easily provided by simple safeguards in the mill.

The use of only one X-ray tube is doubly advantageous. Accuracy is unaffected by voltage harmonics in the plant power supply. The tube is encased in a heavy steel plate tank well below the strip and certainly out of the path of any "cobbles."

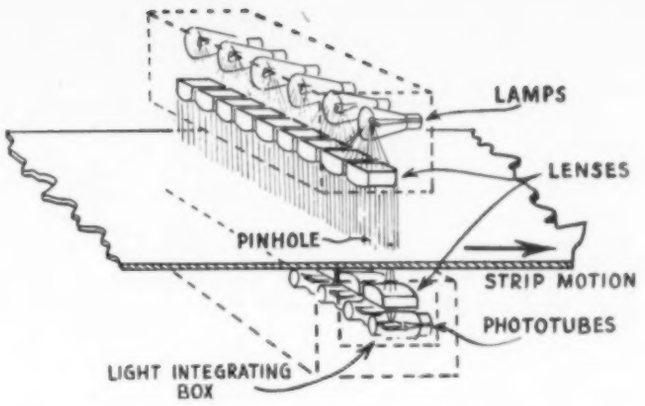


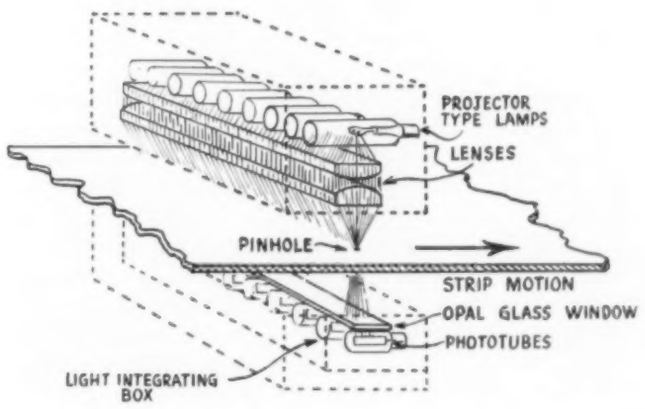
Figure 8 — The super-sensitive pin-hole detector can be operated at higher speed and detect smaller holes than the standard unit.

SUPER SENSITIVE PIN-HOLE DETECTOR

Recently a super-sensitive scanner was developed to detect even smaller pin-holes in tin plate than before. This new equipment will detect pin-holes as small as 0.005 in. in diameter at strip speeds from 50 to 1000 fpm. The previous pin-hole detector could only indicate the presence of pin-holes three times this diameter or larger, and only up to 900 fpm.

The new scanner uses a different optical system from the standard detector. In the old system a rectangular area of fairly bright light fell upon the tin plate, whereas the new system uses a compound lens to concentrate the light into a thin intense line across the strip width. This results in the transmission through a smaller pinhole of the same amount of light necessary to operate the phototube system.

Figure 9 — Standard pin-hole detector.



As in the older machine, the strip is passed through the detector which "sees" the pin-hole and produces a voltage which is fed to an electronic timer on a control panel. This timer delays operation of a marking device until the pin-hole has moved adjacent to the marker. The control panel also initiates the operation of the diverter gate which allows the cut sheet containing the pin-hole to be rejected. The new scanner has two steel boxes, one mounted above the other separated by a small space, through which the strip passes. The upper box for a 40 in. width of strip contains 31 theater type photocell exciter lamps which have straight filaments. The older light sources used 20 automobile headlight bulbs. In the old scanner this light was projected in parallel rays by one series of lenses across the gap to another series of lenses in the lower box which focused any light through a pin-hole in the tin plate on one of 20 phototubes (Figures 8 and 9).

On the other hand, instead of a separate lens for each lamp and phototube, the new light source has two cylindrical lenses extending the full 40 in. width. These lenses cause images of the lamp filaments to be projected upon the surface of the strip. Light passing through a pin-hole will fall upon a phototube after passing through a diffusing opal glass window.

For operation on a strip narrower than 40 in. the detector uses a pair of adjustable shutters to shield the end phototubes. These overlap the strip by ½ in. allowing for ¼ in. lateral movement. Thus, a ½ in. strip on each edge of the tin plate is not scanned.

The new detector can be provided with floating shutters, which follow any lateral movement of the tin plate by rollers which ride against the edges of the strip. This makes it possible to detect pin-holes to within ⅛ in. of either edge of the strip.

SYNTHETIC CURRENT TOTALIZER

So that he is able to correlate properly the speed with the plating current, the operator of a tinning line should be able to read the total current.

Rather than run a heavy power-consuming bus from each high current rectifier or generator section distributed along the plating line and through a large, expensive shunt able to carry possibly 60,000 amperes continuously, the synthetic current totalizer totalizes the plating currents without bringing the actual circuits together.

One such equipment has been installed in the Aliquippa works of the Jones and Laughlin Steel Corp. Combining the indications from a number of individual 50 or 100 millivolt shunts in each plating rectifier or generator section, an average value representing the total current is obtained. This is applied to one coil of a specially rugged industrial type of galvanometer. This tends to deflect the galvanometer mirror so as to reflect light from a light source onto a phototube. The output of the phototube is amplified and supplies the control field of a rotating regulator. A portion of the output of this regulator is fed into the second coil of the galvanometer and tends to deflect the mirror in the opposite direction, so that a state of equilibrium exists when the current flowing in the second coil equals the current from the combined shunts. The indication of total current is given by the output voltage of the rotating regulator which follows the totalized shunt voltage from zero to the rated current of the shunts.

Hunting is avoided by a mutual inductance feed back between the two coils of the galvanometer and the amplifier circuit.

The totalizer can be made into a current-speed regulator so that the totalized plating current varies as a function of the speed of the tinning line. (Figure 10).

The output of the above rotating regulator is fed into the field of a second rotating regulator which is also supplied from a tachometer generator connected to one of the line drive motors.

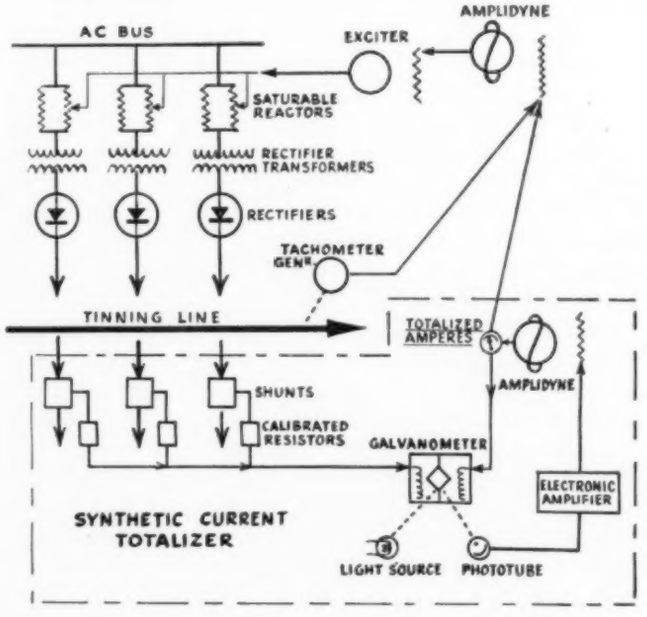
The resulting output from the second rotating regulator controls the field of the exciter whose output in turn supplies the voltage to the d-c windings of the saturable core reactors in the primaries of the rectifier transformers. Each reactor has an a-c winding of reactance (and therefore, voltage drop) depending on the amount of magnetic saturation produced by the d-c winding. Thus, the primary voltage of each rectifier transformer and the plating current from each rectifier is controlled easily and accurately.

All the electronic devices in the totalizer are mounted on resilient supports so there is no danger of vibrations of the line affecting the performance or life of the equipment.

FACTORY BUILT EQUIPMENT

It is reassuring to a plant manager to buy an equipment such as a unit substation and to be able to forget the worrying details of fitting the ratings of the switchgear devices with the transformer's capabilities. Following this theory of relieving the purchaser of attending to proper co-ordinating of a number of associated

Figure 10 — Synthetic current totalizer and associated equipment forms a current-speed regulator for a tinplating line.



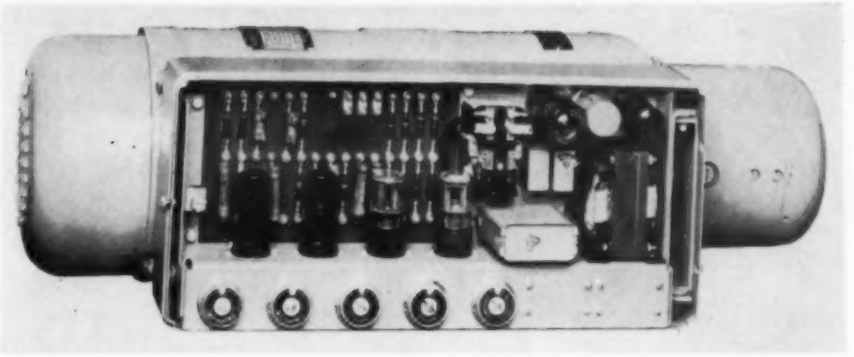


Figure 11 — The electronic rotating regulator can be had in a packaged unit.

devices, excellent results have also been achieved in the field of electronics applications to industry.

Of late, the trend towards automatic operation with its closer control and faster response has added to the complexity of control equipments. Greater numbers of devices of major function are linked together by an ever increasing horde of bits and pieces on the proper selection of which depends the entire control operation.

ROTATING REGULATOR AMPLIFIER

For over seven years now, both rotating regulators and electronic control devices, either working separately or in conjunction, have become well known and generally accepted by the industry.

Quite recently a rotating regulator power package was developed. The significance lies not in what new feats it may accomplish, but rather in the fact that such a combination is no longer custom-tailored but is a standardized unit, capable of being produced in great numbers at a price which will make its use economically attractive in a larger number of cases (Figure 11).

The package consists of a 1500-watt rotating regulator unit with a 150-watt direct-connected exciter, and mounted on one side, in a compact enclosure an electronic amplifier and regulator. The many uses to which the rotating regulator amplifier package may be put, taxes the imagination. One simple one is that of restricting speed regulation of a motor to plus or minus one per cent. A tachometer generator on the motor supplies a voltage to the electronic portion which compares it with an adjustable reference voltage from a built-in voltage regulator tube. This tube makes use of the inherent property of conducting gas to hold a constant potential drop. If a difference (error voltage) exists, the electronic portion varies the field of the rotating regulator portion, which in turn bucks or boosts the field of the motor or the generator supplying it, to hold constant speed.

Another job is that of proportioning load among motors. This prevents one motor of a group from being so overloaded that it burns out, while one or more other motors in the group may not be fully loaded. In this application, the line current is compared with a reference by the electronic portion which in turn controls the action of the rotating regulator to raise or lower the motor speed until the motor is properly loaded. An anti-hunt feature is built into the unit and insures smoothness when the motor is working to the safe limit of its ability.

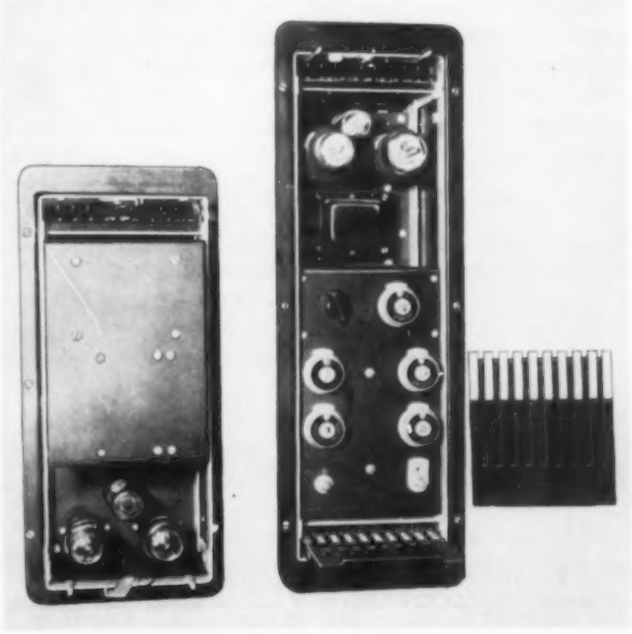
REGULATING SYSTEMS

Complete control systems are being applied today to regulate automatically a number of industrial values like speed, voltage, current, tension, thickness, etc. The regulating equipment used depends on the individual problem but in general each contains a preamplifier and a final amplifier for controlling the driving equipment, motor or generator. Both the preamplifier and the final amplier can be electronic, rotating regulator or magnetic (saturable core reactor) or a combination of these to achieve the desired results.

For machines up to about 500 kw which require an extremely high speed of response and close regulating accuracy to less than plus or minus one-half of one per cent, the fully electronic regulator may be used. While it is not recommended for subjection to heavy vibration or shock, there are no moving parts and hence maintenance expenses are cut very low.

Using an electronic preamplifier and a rotating regulator final amplifier, the size of the machines regulated can be increased to about 3000 kw. The speed of response is slightly slower than that of the fully electronic regulator, but nevertheless is still very fast. It has been applied to good advantage for steel mill drives and

Figure 12 — Drawout-type of construction for use with electronic rotating regulator. Power supply unit is at left; amplifier is at right.



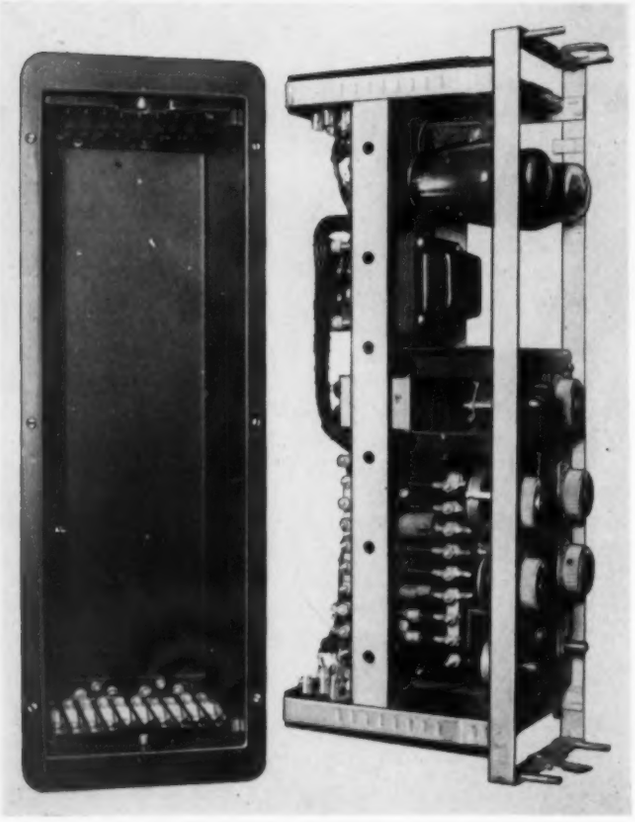


Figure 13 — The electronic amplifier is shown drawn out for ease of inspection or maintenance.

power rectifier regulation. The electronic portion of this regulator has been designed to fit into the flush-mounted drawout type cases which are so widely liked for their convenience in testing and adjustment when used to contain switchgear relays and meters. The amplifier proper is housed in a case similar to that for a three-element watthour meter while its power supply is housed in a second medium-sized case (Figure 12 and 13).

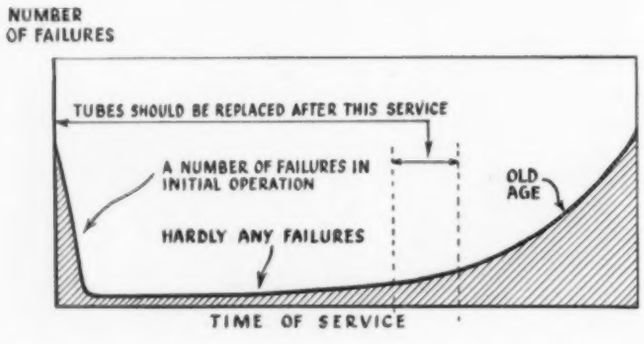
The two combinations magnetic diagonal rotating regulator and magnetic/magnetic regulators are designed for industrial applications requiring essentially shock-proof equipment. The latter has the added advantage of being completely static having no moving parts to wear out.

One of the most important characteristics of all these combination regulators is that they have no dead band of operation. That is, there is practically no minimum error that has to be exceeded before the regulator takes corrective action, as the equipment begins correcting immediately the tendency to vary has become a reality.

The industrial electronic equipments described have been completely checked. The design engineers no longer allow laboratory prototypes to become production models without the most rigorous and thorough analysis of the electrical, mechanical and thermal characteristics. The manufacturer's aim is dependability of operation and the constant answering of the question: "What will this equipment do better than any other?"

The manufacturers of such equipment should be given the fullest opportunity to discuss application with industry, the objects being greater production and lower cost through proper application. It is obvious that the extraction of the greatest benefit from the use of industrial electronics is dependent upon the perfect dovetailing of the requirements of the individual process with the capabilities of the control equipment. In this way the investment is adequate without becoming excessive.

Figure 14 — A typical curve of tube life is shown. Each type of tube would have a separate curve.



MAINTENANCE

It should be borne in mind, however, that after all, electronic equipment does look a little unfamiliar to the average maintenance man. So much of its success depends upon proper preventive servicing. It is inconceivable, no matter how well built the equipment, that full utilization can be obtained without some effort on the part of the user to provide a suitably trained staff to do this job. Helpful information on the equipment should be obtained from the manufacturer, men with sufficient ability properly trained, and a regular maintenance schedule set up.

All this does not mean that electronic control is so delicate that it requires continual readjustment by a laboratory technician. On the contrary the maintenance man with ability and the addition not only of common sense but of specialized training, can certainly make the continued operation of the equipment successful. Let it be remembered that either ability or training alone is not sufficient. The expense of high quality maintenance is a cheap price to pay considering the returns to be enjoyed.

TUBE TESTING

The question "Shall we test tubes or not?" is a controversial one. Some users send a maintenance man around the plant at definite intervals, armed with sufficient of the relatively inexpensive communication type tubes to replace every such tube in use. Some other users never touch a tube in use until it has failed. It is difficult to suggest a definite policy for all sized plants because of the lack of statistical data on the life expectancy of each different tube.

Perhaps some general comments will at least help the user in some measure to get more for his money. Having something on which to base tube servicing is the

first step. It is necessary that an accurate history be kept of each individual tube in use or held as a spare. This information plus any that the tube manufacturer can add will allow the user to determine an approximate life for each type of tube in the equipment in his plant. It is a well-known fact that most tubes fail in much the same way. The equipment operates well until shutdown and then the next time the equipment is restarted, the tube has failed or fails immediately. As in fluorescent lights (another example of electronics) it is the starting and stopping rather than the steady operation that adds to the troubles which the tube must withstand. Another well-known experience is that a new tube will either fail soon after it is installed or not until its service hours have reached the average life expectancy for that type of tube. In other words, if the new tube operates satisfactorily for a while after it is put in service, then no trouble from it should be expected until the end of the normal life for such a tube. After sufficient experience, the user will be able to judge for himself just how often tubes of different types should be replaced (Figure 14).

Spare tubes should be usable spare tubes. While it is not recommended that tubes properly functioning should be removed and then replaced in their sockets to any great extent, still in order to test spares, some definite scheme must be instituted to make sure that a spare tube is a spare and not just a dud. Checking once is insufficient; the testing of spares should be periodic. The time to order spare tubes is when the equipment using such tubes is first ordered. This is only common sense derived from the greater probability of tube failure when tubes are first installed.

These cautions should not deter the user one iota from making use of the proper electronic equipment. The advantages of such use far outweigh any minor servicing inconveniences.

COAL GASIFIER OPERATES SATISFACTORILY IN INITIAL TESTS AT BUREAU OF MINES DEMONSTRATION PLANT

▲ IN the work being carried on by the U. S. Bureau of Mines on synthetic liquid fuels from coal, a successful full-scale test run had been made in the new coal gasification unit at Louisiana, Mo.

A part of the Bureau's gas synthesis (Fischer-Tropsch) demonstration plant, this coal gasifier was built for direct production of synthesis gas from finely powdered coal and oxygen. It is the second of the plant's five units to be completed. An oxygen production unit has been in operation for several months, and it is anticipated that the remaining units for gas purification, hydrocarbon synthesis, and product refining will be finished and in operation during 1950.

Gasification, however, is the prime cost and process problem now requiring solution before competitive gasoline and oil can be made from coal by either of the two basic processes employed in the recently-dedicated plants at Louisiana. In the Fischer-Tropsch process, the synthesis gas—a carbon monoxide and hydrogen mixture—obtained by coal gasification constitutes roughly 60 per cent of the cost of the liquid fuel products. In the coal-hydrogenation process, the hydrogen obtained thereby now represents 40 per cent of the product cost. Therefore, a low-cost gasification method applicable to all types of coal is imperative.

The new type continuous gasifier at Louisiana does not require the use of coking coals. Briefly, its cycle involves first crushing, pulverizing, and drying the coal. Then, suspended in oxygen and accompanied by superheated steam, the coal is fed into both ends of the gasifier—a refractory-lined horizontal steel cylinder with interior dimensions of 6½ by 9 ft. There the conversion to synthesis gas takes place at temperatures up to 2500 F. The unit is designed to use about 28 tons of coal, 24 tons of oxygen, and 35 tons of superheated steam, and to produce some 2,000,000 cu ft of raw synthesis gas daily.

Steam required for gasifying the coal is superheated in a pebble heater fired by gas. The oxygen is extracted from the air at temperatures more than 300 F below zero in a Linde-Frankl unit originally used in making chemicals at Hocht, Germany.

Recently, as part of a ten-hour period of operation, a four-hour test was made with all six burners operating at design capacity and with gasifier temperatures averaging about 2200 F. Again the operation was all that could be expected at this stage of the development, and the shutdown was made voluntarily with no conditions in sight that might have forced it. During this period the feed rates were:

Coal—2300 lb per hr.
Oxygen—17,000 standard cu ft per hr.
Steam—2000 lb per hr.

Approximately 70,000 standard cu ft per hr of gas were made containing 37 per cent carbon monoxide, 42 per cent hydrogen, 16 per cent carbon dioxide, four per cent nitrogen, and one per cent miscellaneous.

Bureau engineers are hopeful that they can reduce the carbon dioxide content and obtain a higher yield of still better synthesis gas in subsequent runs after they have become more familiar with the operating characteristics of the new gasifier. Considerable work remains to be done before the gasifier is put in continuous operation. However, the trial runs apparently could have been maintained over longer periods and are deemed encouraging as to the ultimate success of the operation.

SLEEVE BEARING DEVELOPMENTS

. . . . developments in precision type bearings for engine applications usually lead to advancements in mill applications . . . .

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▲ THOUGH the sleeve bearing material combinations available today differ but slightly from those used five to ten years ago, design, metallurgical and manufacturing refinements have kept the sleeve bearing industry abreast with most of the requirements of engine and machine designers. The progress has been slow and unspectacular, yet certainly worthy of recognition as valuable contributions to the metallurgical and mechanical arts.

BEARING LINING MATERIALS

Bearing lining materials in general use today are classified into the following major groups:

1. Tin base babbitts.
2. Lead base babbitts.
3. Cadmium alloys.
4. Copper alloys.
5. Aluminum alloys.
6. Silver.

Since Isaac Babbitt's discovery of a white metal bearing material in 1839, metallurgists have tried to improve upon his original alloy with limited success. These white metals, now generally termed "babbitts" are many in number and highly advertised for their superior bearing qualities. Actually none of them are much better than Babbitt's metallurgical masterpiece. SAE No. 12 has proven to be about the best compromise in the tin base babbitt family, very closely approximating Isaac's original analysis.

With the disappearance of tin during the past war, lead base babbitts received their just recognition. Previously, they had been given minor consideration with little or no effort being made to explore their possibilities. As in the case of the tin base babbitt group, there is also a profusion of lead base babbitts available. These can be roughly divided into three major categories; the tin hardened group, the arsenic hardened group and the alkali hardened group. The first two are, by far, the most popular. SAE specification numbers for them are No. 13 and No. 15, respectively.

About six or seven years ago the greatest improvement in babbitt bearings was made with the development of manufacturing techniques which would permit their production with lining thicknesses as thin as 0.002 to 0.005 in. The increase in fatigue resistance and consequential load-carrying capacity resulting from this, enabled the automotive engine manufacturers to increase the power output of their engines without the need of using a premium priced, heavy duty bearing.

Because of the scarcity and high cost of cadmium, now $1.90 per pound, little is being done with the cadmium bearing alloys. It is expected that in the near future their use will be a rarity, due to the improvements being effected in cheaper and better bearing alloys. Cadmium-silver and cadmium-nickel have been outstanding performers in this group.

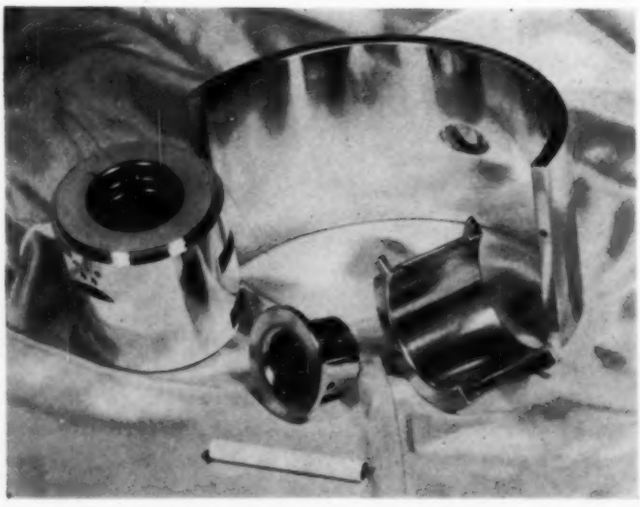
Much has been accomplished in the past several years in developing copper alloy bearing materials. They have moved out of the sensitive, irresponsible class, and are now accepted as proven alloys capable of doing a first-class job within their limited field. The copper-alloy group can be subdivided into three general classifications:

1. Copper-lead mixtures.
2. Copper-nickel matrix lead babbitt combination.
3. Leaded bronze.

The copper-lead mixtures, containing 25 to 35 per cent lead predominate. In some processing methods a small percentage of silver is added to obtain the necessary microstructure refinement. Most copper-leads are given some surface treatment to enhance their bearing qualities. It may be either an overlay of lead-tin or merely a diffused indium treatment.

Surface treatment of copper-leads is largely respon-

Figure 1 — Typical bronze back babbitt lined bearings.



Presented before AISE Annual Convention, Cleveland, Ohio, October 1, 1948

sible for this general acceptance as a suitable heavy-duty bearing material. Being a relatively hard metal, susceptible to corrosion by some organic acids, and lacking the high degree of embeddability and conformability characteristics of the babbitts, made it necessary to adopt such techniques.

The perfection of precision electroplating made such steps possible. At the present time a large percentage of copper-lead bearings are plated on the bearing surface with an alloy of lead and tin to a nominal thickness of 0.001 in. The lead-tin alloy, usually containing 4 to 12 per cent tin, is quite soft, enabling the bearing to handle a greater degree of shaft and housing misalinement, shaft deflection and foreign material in the lube oil, than is possible with the unplated bearing. The overplating also permits the use of shafts with a hardness as low as 250 Brinell, against a recommended minimum of 300 Brinell for the unplated bearing. It has also been beneficial in getting the engine through the initial break-in period, which proved so troublesome in the early days of copper-lead development. Corrosion of the overplate is prevented by the tin additive.

Another surface treatment intended to prevent copper-lead bearing corrosion is the diffusion of indium into the copper-lead material. This is usually accomplished by electroplating a very thin coating of indium upon the bearing surface and then diffusing it into the lead of the copper-lead lining, usually by heating in oil at 350 F for about one hour.

Another copper base alloy bearing now being used extensively is also in the three-layer class. The intermediate layer or matrix applied to a steel back is a metallic sponge-like structure, consisting of 60 per cent copper and 40 per cent nickel. Over the matrix is cast a lead base babbitt, which is later machined to give a final nominal babbitt thickness of 0.003 in.

In the leaded bronze group we have another contribution to the heavy-duty bearing class, the gridded bronze. SAE No. 67 bronze, centrifugally cast, constitutes most of this bearing. The bronze bearing surface is gridded or indented. These grids are filled with a lead base babbitt. Over this finished surface is electroplated a lead-tin alloy about 0.002 in. thick.

We have still further, another variation in the "sandwich bearing class," which is also quite popular in the heavy-duty field. Onto the steel backing of this bearing is centrifugally cast a leaded bronze, usually SAE No. 64. Excess bronze is removed to give a final bronze thickness of $\frac{1}{32}$ in. Tin or lead base babbitt is then centrifugally cast over the bronze. In subsequent machining operations the final babbitt thickness is reduced to 0.005 in.

Aluminum alloy bearings have definitely been proven as excellent heavy-duty types. The solid versions made from permanent mold castings are now in quantity production for several producers of large engines. In all cases, heavy bearing wall sections are employed. Thin wall, strip or cast aluminum bearings have not been satisfactory in most applications. The development of steel back, aluminum alloy lined bearings has been considerable within the past several years. It may be expected that the few remaining production problems will soon be solved and that such bearings will be available in volume at reasonable prices. To date the best alumium bearing material for the solid or bi-metal types appears to be an alloy containing 7 per cent tin with small percentages of nickel and copper.

The remaining bearing material on our list is silver. When applied to a steel back and overplated with lead it becomes our highest rated bearing type insofar as load-carrying capacity is concerned. Unfortunately, its high cost prevents its use in most industrial applications, being confined to high-powered military or commercial aircraft engines.

BEARING BACKING MATERIALS

Bearing backing materials are not as profuse as lining alloys, but there is a sufficient number to easily confuse the unitiated. Sleeve bearings are today made with the following backings:

1. Bronze.
2. Cast iron.
3. Low carbon steel.
4. Low grade alloy steel.

Figure 2 — Steel predominates as a backing for babbitt lined bearings.

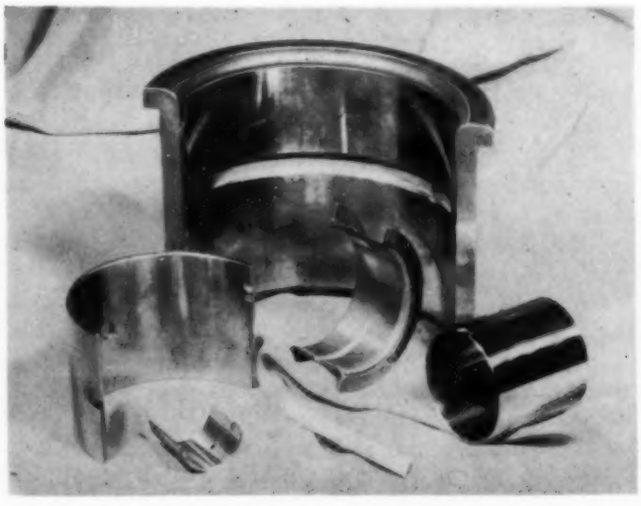
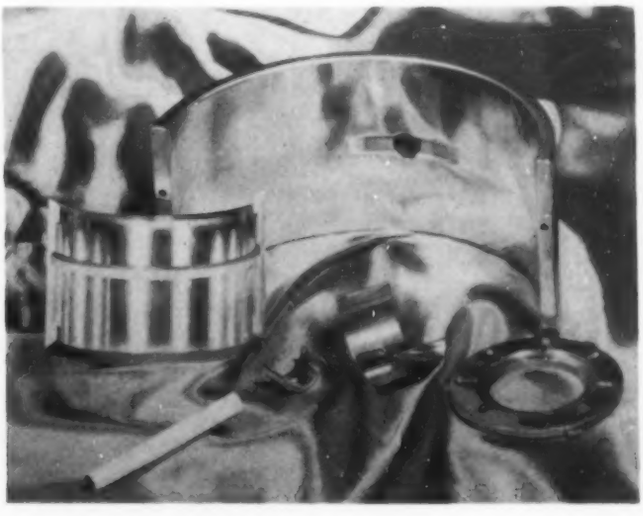


Figure 3 — Typical steel back copper-lead bearings (unplated).



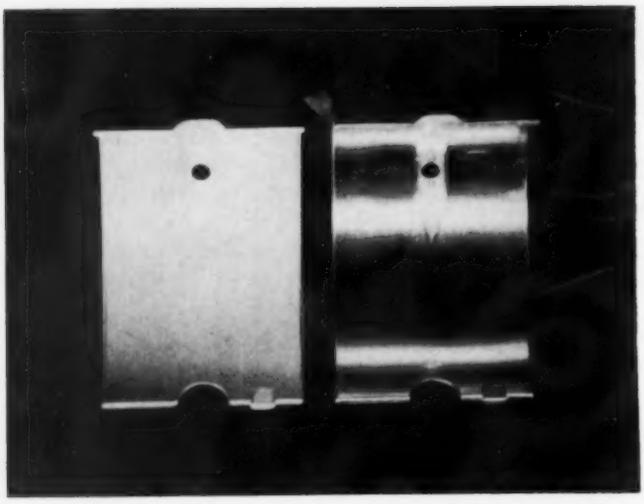


Figure 4 — Typical copper-lead bearings before and after overplating. Plating is intended to prevent bearing corrosion.

There is, of course, a multitude of bronzes available. The more popular ones are SAE No. 40, SAE No. 64, SAE No. 66 and SAE No. 660. SAE No. 64 is about the best compromise, being cheap, easily cast and machined, and babbitts are readily bonded to it.

With the perfection of a process for obtaining a chemical bond on cast iron several years ago, came its use as a suitable and economical bearing backing. Though its use has been confined to large, heavy wall, low volume bearing production, it cannot be overlooked.

Low carbon steels predominate as a bearing backing, either in strip, tubing or forged forms. SAE No. 1010 or No. 1020 is preferred.

In certain thin wall, heavy loaded applications, improved bearing performance is obtained with the use of a low-grade alloy steel which possesses higher physical properties than the common low carbon steels.

BEARING MATERIAL COMBINATIONS

Because of certain metallurgical reasons, not all of the available lining materials can be properly bonded to the backing materials just discussed. All the tin base babbitts and the tin hardened and alkali hardened lead base babbitts can be suitably bonded to steel, bronze or cast iron. The arsenic hardened lead babbitts can be applied only to steel and cast iron. All cadmium alloys, all copper-leads, copper-nickel, matrix and all aluminum alloys and silver bond easily to steel only.

BEARING MANUFACTURING METHODS

In attempting to describe bearing manufacturing methods, we shall confine ourselves to the operations concerned with applying the bearing lining material to its backing. All other operations can be classed as ordinary machining operations entailing the use of lathes, presses, broaches and boring machines.

There are four methods that can be followed in producing a sleeve bearing. They are:

1. By static casting.
2. By centrifugal casting.
3. By electroplating.
4. By application on a continuous steel strip.

Comparatively few bearings are today statically cast because of the slowness of the operation and the doubtful quality of the casted material, with regards to bond and microstructure. Refinements to this age-old process were made to produce a high quality copper-lead bearing, however. One popular method of producing this bearing utilizes an outer cylinder, which is actually the bearing back, assembled over a carbon core or a low carbon steel core. A crucible cup with plug in place is set on top of the cylinder and the complete assembly is then placed in a neutral-atmosphere furnace and brought to red heat. Upon removal from the

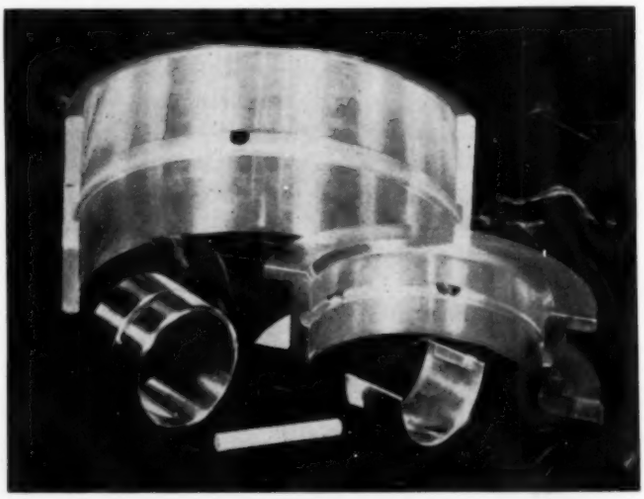


Figure 5 — Aluminum bearings are particularly good for heavy duty service.

furnace the assembly is placed on a pedestal projecting from an open water tank. The molten copper-lead is poured into the cup from an induction furnace, the plug is pulled out of the crucible and the melt runs into the cylinder. The pedestal lowers the assembly into the water tank at a predetermined rate to effect the desired microstructure upon solidification. After cooling, the cup is removed, the core machined out, leaving a steel tube, lined with copper-lead suitable for machining into either a full round or half bearing.

All lead and tin babbitts, cadmium alloys, some copper-leads and aluminum alloys may be statically cast on their backings.

Centrifugal casting of lining materials is practically universal when applying them to tubular shaped backings. For relatively large production, automatic machines having six or eight spinning spindles are used. Only the tin and lead babbitts, cadmium alloys and bronzes containing less than 10 per cent of lead are centrifugally cast.

Electroplating, being a comparatively slow process is restricted in its use. It is, of course, used to apply the lead-tin overlays on copper-leads and gridded bronzes. In addition to flashing tin, copper or cadmium plating on the backs of steel backed bearings to prevent rusting in storage, the process is used to deposit pure silver on steel backings.

The application of bearing materials to a continuous

steel strip has been one of the most noteworthy developments in the past ten years. The perfection of this process has made possible the production of high quality, heavy duty bearings at very reasonable costs.

All tin base babbitts, most lead base babbitts, many copper-leads, copper-nickel matrix, aluminum alloys and silver can be applied to a continuous steel strip.

The general size limitations of strip type bearings can judged by the steel strip used. Its thickness range is from 0.036 to 0.130 in. up to a maximum width of 6 in.

Babbitt type bearings require the steel be coated with tin about 0.0002 to 0.0005 in. thick, whereas the copper alloys may be bonded to either tin or copper coated or bare strip.

In describing a typical babbitt strip applicator, we start with a heavy roll to straighten the strip and to remove surface irregularities. It then passes through a gas fired or electric preheating oven, maintained at 800 F, and immediately to the babbitt applicator. Molten babbitt is siphoned or pumped from its pot and spread upon the moving strip. Sealing rails to which babbitt will not adhere, on either side of the strip, confine the babbitt flow in the crosswise direction. Because of the speed of the strip through the applicator and the rapid solidification of the babbitt after pouring, it is not necessary to restrict the babbitt flow in the lengthwise direction.

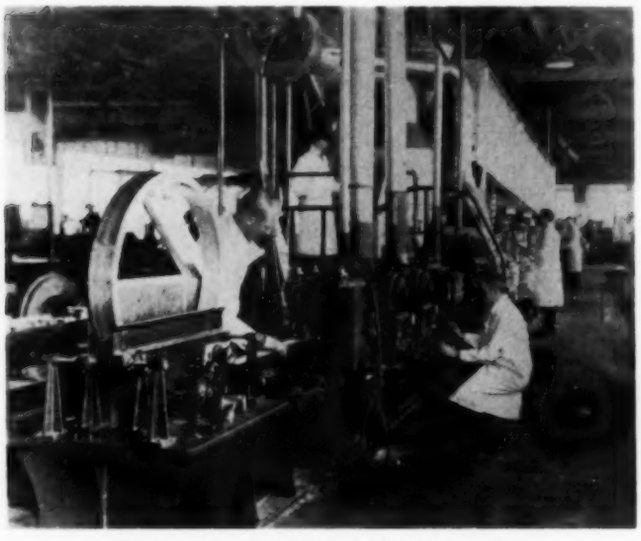


Figure 6 — Typical babbitt strip mill.

Following this is a rough milling operation on the babbitt to remove a major portion of the excess, succeeded by a skiving operation to complete the removal of the excess babbitt. The bi-metal strip thickness is held to a 0.003 in. tolerance by this shaving operation. At the end of this sequence, the strip is recoiled and stored until needed. The speed that the stock is moved through the mill ranges from 6 to 16 fpm, depending upon the size of the strip.

Many manufacturers have tried to confine babbitt strip bearings to one tin base babbitt, SAE No. 12, and one lead base babbitt, SAE No. 15, to effect more economical operations.

SAE No. 15 lead babbitt, being somewhat brittle in the "as cast" state, requires that such bi-metal strip be

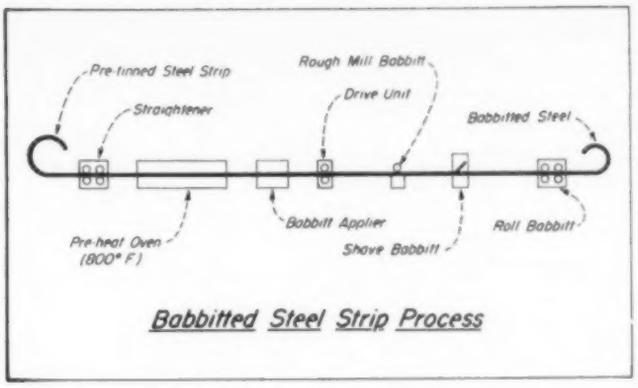


Figure 7 — The operation of the babbitt strip mill is a continuous process.

subjected to an annealing process. After recoiling, the babbitted strip is placed in an oven at 370 F for four hours. After this treatment, the coil is run through a brushing machine to remove the oxidation film from the steel, which, if left on, would cause the stock to stick in subsequent press operations.

Production of copper base, aluminum and silver bi-metal strip is somewhat similar. In applying copper base materials, some manufacturers apply them while in the molten state, while others have selected a mixed or pre-cast sintered metal powders method.

The sintered powder method is rather unique. Beginning with a rolling operation to straighten the strip, the powder is spread upon it from an overhead hopper, passes under a leveling device, and into a neutral atmosphere electric sintering oven maintained at 1500 F. This oven is 75 ft long. Immediately following the oven is a 50 ft cooling chamber which lowers the strip to nearly room temperature. A hard roll is then given the bi-metal to increase the density of the copper-lead and to improve the bond. The strip is recoiled, placed in another oven for its second sinter, given another roll and again recoiled, ready for fabrication into bearings. Sintered powders can be applied to the strip at the rate of 40 to 56 in. per minute.

When required, the bi-metal strip coils are taken from the warehouse and fed through a high speed blanking press. This press cuts the strip into flat

Figure 8 — Typical sintered copper-lead strip mill.

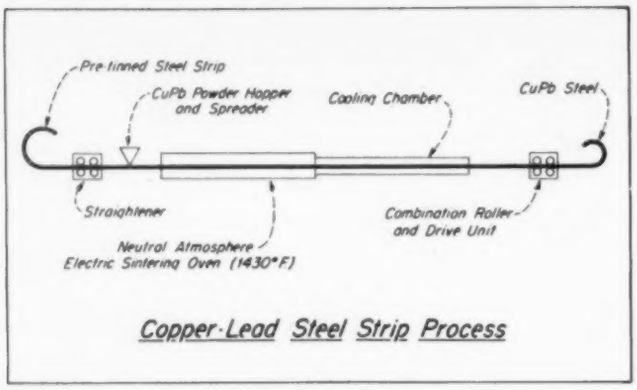


Figure 9 — Diagram of sintered copper-lead strip mill. Speed ranges from 40-56 in. per minute.

blanks, their size being determined by the finish size of the bearing desired. The blanks are then stacked with the bearing material side up and hopper fed into the forming and coining press. Here, a two-stage die is used. In the first stage, the flat blank is formed into a "U" shape, then slid into the second stage to be coined on the parting faces. This coining operation assures a smooth, even, accurate bearing back. No further machine work is done to the bearing back. Succeeding are the usual grooving, punching and broaching operations.

POPULARITY OF BEARING MATERIAL COMBINATIONS

Even though there is an imposing list of bearing material combinations available, there are a few which dominate the field as far as quantity consumption is concerned. This, of course, is due primarily to the requirements of the automobile, truck and tractor industry.

In 1947, sleeve bearing manufacturers produced on the average 600,000 pairs of bearings each working day. Of these, approximately:

54 per cent were strip type lead babbitt bearings,
14 per cent were strip type copper alloy bearings,
10 per cent were strip type tin babbitt bearings,
6 per cent were centrifugally cast lead babbitt bearings,
5 per cent were centrifugally cast tin babbit bearings,
3 per cent were statically cast copper-lead bearings.
3 per cent were centrifugally cast cadmium alloy bearings,
1 per cent were solid aluminum alloy bearings,
less than 1 per cent were electroplated silver bearings.

The remaining 3 or 4 per cent was made up of miscellaneous types.

Actually 60 per cent of the bearings produced were lined with lead base babbitt and 15 per cent were lined with tin babbitt. Thus, 75 per cent of all bearings produced in 1947 were lined with babbitt.

Bearing cost was a major determining factor in many selections. In these days of rising costs, it is not difficult to understand why many engine and machine designers hold their bearing loads within the babbitt bearing range.

RELATIVE BEARING COSTS

Assuming a basic bearing design of the automotive type, and making a cost analysis of it covering many of the available material combinations, a very interesting comparative price table results. The strip type lead babbitt version of this design is the most economical and is estimated to cost fourteen cents. With this base price, the estimated costs of other types having the same design are:

Tin babbitt on steel strip	18 cents
Unplated copper-lead on steel strip	23 cents
Overplated copper-lead on steel strip	25 cents
Centrifugally cast lead babbitt on steel	28 cents
Centrifugally cast tin babbitt on steel	32 cents
Cadmium alloys on steel	41 cents
Cast solid aluminum alloy	51 cents
Overplated static cast copper-lead on steel	80 cents
Overplated silver on steel	250 cents

TYPICAL INSTALLATIONS

In covering the list of sleeve bearing consumers, it is to be noted that manufacturers of similar mechanisms tend to use about the same sleeve bearing material combinations. Considering the most heavily loaded bearing in the machine, the following materials predominate in various applications:

Passenger car and light truck engines—Lead babbitt on steel.

Heavy truck engines—Overplated copper-lead on steel.

Light farm tractors—Lead babbitt on steel.

Heavy tractors and crawlers—Overplated copper-lead on steel.

Marine diesels—Tin babbitt on bronze or steel.

Road locomotive diesels—Overplated copper-lead on steel.

Stationary diesels—Tin or lead babbitt on steel or bronze.

Light aircraft engines—Overplated copper-lead on steel.

Figure 10 — Strip blanking presses.

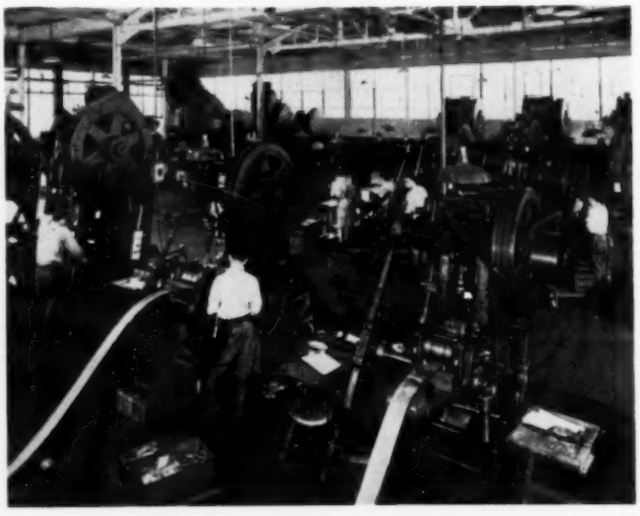


Figure 11 — Strip forming and coining press.

High powered aircraft engines—Overplated silver on steel.

Steam turbines—Tin babbitt on bronze.

Refrigeration compressors—Tin babbitt on steel.

Agricultural spray pumps—Tin babbitt on steel.

AVERAGE BEARING LIFE

The life of sleeve bearings is usually entirely dependent upon the care and type of operation given the engine or machine. Assuming that the operator follows the instructions of the machine's builder as to use and care of it, the average life of the most heavily loaded sleeve bearing in it will be for:

Passenger cars and light trucks	75,000 miles
Heavy trucks	150,000 miles
Tractors and crawlers	5,000 hours
Marine diesels	10,000 hours
Stationary diesels	15,000 hours
Road locomotive diesels	250,000 miles
Aircraft engines	1,000 hours
Steam turbines	15,000 hours
Refrigeration compressors	10,000 hours
Spray pumps	5,000 hours

DISCUSSION

PRESENTED BY

R. A. KRAUS, General Millwright Foreman, Republic Steel Corp., Chicago, Ill.

ANDREW CICHELLI, Lubricating Engineer, Bethlehem Steel Co., Sparrows Point, Md.

C. E. PRITCHARD, Chief Lubrication Engineer, Republic Steel Corp., Cleveland, Ohio

ALBERT WILLI, JR., Assistant Chief Engineer, Federal-Mogul Corp., Detroit, Mich.

R. A. Kraus: The author's subject was primarily concerned with automotive and diesel equipment and other precision applications as applied to our industry, rather than with the heavier and more cumbersome equipment which is so frequently associated with the name "Steel Industry."

His information on lead and tin base babbitts and other materials will undoubtedly be of considerable interest to all, and should prove quite valuable to those confronted with immediate problems of this nature.

Perhaps a further elaboration on his general title, "Sleeve Bearing Developments," would include sleeve bearing types other than the metallic types covered. Sleeve bearings of tungsten, tantalum and boron carbide are quite new and are now coming into successful use in a number of applications; and of course there are the better known carbon composition sleeve bearings and fabric bearings, both of which have shown considerable promise for wider development and use.

It is recognized that these types do not necessarily lend themselves directly to automotive or diesel work but they do apply satisfactory to many of the sleeve bearing problems encountered in connection with other steel mill applications.

Our experience with the fabric bearing has been much the same as many other plants. These bearings are gaining more favor than formerly, due to the increased knowledge that has been recently gained in their application. Formerly these bearings were considered as satisfactory only in certain mill stands as roll bearings, but now mill table bearings are being fitted, as well as many other similar mill applications. If water is available or in use on the equipment, fabric bearings should be definitely considered.

In a similar manner, carbon bearings have come into use where higher temperatures are involved and where lubrication is not dependable. Bearings of this material can be made to perform satisfactory at temperatures approaching 700 F without lubrication, providing unit loads are not excessive. If higher loads or severe shock conditions are experienced, somewhat lower temperatures are considered acceptable. Installation such as bearings on furnace discharge tables and similar applications now frequently use carbon bearings with water lubrication. In installations such as this, the water tends to cool the roll and shaft as well as lubricate the bearings with a generally increased service life of all units.

In making carbon bearings installations where formerly bearings of other types have been in service, it is not sufficient to just substitute the carbon sleeve for the bronze sleeve or roller bearings. Since carbon is capable of withstanding compressive loads but only relatively low tensile loads, the design must be made so that predominate compressive stresses are sustained by the bearing.

The simplest method for obtaining this stress condition is to shrink the carbon bearing into steel cases on shells, using about a 600 to 800 F shrink fit and then press or clamp this steel and carbon assembly into the final housing.

The extremely hard materials, such as boron carbide and tungsten and tantalum carbides are valuable bearing materials where abrasive conditions are present or

where lubrication is impossible because of temperature or other reasons. Bearings of this type operate successfully due to their extreme hardness, rather than because of any self lubricating property. As a result, the shafts that they operate against of course must also be quite hard. This is frequently accomplished by either shrinking on tool steel tubing sleeves, or by hard surfacing by welding and then grinding to size. In a few applications carbide sleeves are secured to the shaft and operate against other carbide bearing shells.

Applications have been made in sump-pumps, spike machines, coke plant equipment, etc. One noteworthy application was in a sump pump bottom bearing where the bearing outwore all previous materials, including carbon, composition, bronze and ball bearings by about four times the previous life and is still going strong. This was a boron carbide sleeve on a hard surfaced and ground shaft.

One of the biggest objections to using these materials is the difficulty experienced in securing them. They are not capable of sustaining high tensile loads and are quite subject to shock and chipping and consequently must be mounted with care. They should, however, be considered whenever a difficult bearing problem is encountered.

Andrew Cichelli: This paper covered primarily the precision type machine and bearing, and not so much the heavy mill type. However, we in the steel industry always keep ourselves alert to the work being done on the smaller bearings.

We also feel that 1¾ in. babbitt is in the realm of the past. As a matter of fact, we are endeavoring to put some of the developments that you men have made in the diesel field, in heavier equipment. At Sparrows Point, we have gas engine generators and blowers. The crank pin bearings are 22 in. in diameter; across the width of the eye, the bearings are 26 in.

We used to pour babbitt to a thickness nominally three-quarters of an inch; but after repairing them three or four times, we found they reached 1¾ and 2 in., and consequently bearing life decreased accordingly.

We have several bearings under test in which we reduced that thickness to 3/16 in. That is quite thick in comparison to the few thousandths you were referring to, but on the other hand it is quite a reduction in thickness from the babbitt thickness to which we are accustomed.

We did not use any conventional method in applying the babbitt. We first replaced the steel back or cast iron —we had both types—with a bronze shell, and then applied the babbitt by means of a welding torch.

C. E. Pritchard: I would like to ask Mr. Willi what in his opinion was a satisfactory maximum thickness of babbitt that should be adhered to for general mill bearings? Also, would not definite benefits be derived from holding to as thin a lining thickness as possible, from the standpoint of fatigue resistance and load carrying ability?

Albert Willi, Jr.: Replying to Mr. Pritchard's question regarding the maximum babbitt thickness recommendation for general mill bearings, I would like to confirm his statement that there are definite benefits to be derived from holding babbitt lining thicknesses as thin as possible. The fatigue resistance and consequential load carrying capacity of tin and lead base babbitts is inversely proportional to their thicknesses. Unfortunately, it appears that most mill operators either make their own bearings or rebabbitt original equipment bearings as required, and in so doing are unable to obtain the benefits of thin linings. To produce such large bearings with thin linings requires very accurate machining, and usually the mill operator does not have the necessary machinery available to do the job properly.

As a general recommendation, we must say that the lining thicknesses should be made as thin as is economically possible. A specific recommendation would be 0.060 to 0.080 in. for bearings greater than 12 in. in diameter, and 0.030 to 0.050 in. for bearings under 12 in. in diameter.

EXPERIMENTAL SHALE-OIL REFINERY GOES INTO OPERATION

▲ ANNOUNCING completion of the first continuous shale-oil refinery in this country, the U. S. Bureau of Mines states that the new 200-barrel-a-day experimental unit near Rifle, Colo., has been put "on stream" without difficulty.

A highly flexible, continuous unit, the refinery is designed to produce gasoline, diesel fuel, heating fuels, and fuel gas from crude shale oils extracted at the Bureau's oil-shale demonstration plant.

Major pieces of equipment include a furnace or heater, two coking chambers, a combination flash vaporizer and fractionator, stripper for the diesel fuel fraction, stabilizer for the naphtha fraction, absorber, and a rerun column for acid-treated gasoline.

The fractionation section is conventional. Heavy fuel residuum is withdrawn from the flash vaporizer at the base of the fractionating tower. Gas oil and diesel fuel are taken off as sidestreams from the fractionator, and the diesel fuel is stripped of its light components before being stored. The gasoline fraction is taken overhead as a vapor and condensed. Uncondensed gases go to the absorber where condensible hydrocarbons are recovered and returned to the fractionator. Condensed gasoline is pumped to the stabilizer for removal of excessive butanes and lighter hydrocarbons. The stabilized gasoline is sent to the chemical treating unit.

In the treating unit, distillate first receives a dilute caustic wash for removal of hydrogen sulphide, light mercaptans and tar acids. This is followed by a dilute sulphuric acid wash for removal of nitrogenous compounds, commonly called tar bases. Thus freed of chemically active compounds, the distillate is subjected to counter-current extraction with concentrated sulphuric acid for sulphur removal, etc. Next it is washed with water and neutralized with a dilute caustic treatment. Following chemical treatment, it is redistilled to remove the polymers formed in acid treating, and the end point distillate is returned to the treating plant for "doctor" sweetening.

SHEET, STRIP AND TINPLATE INDUSTRY

in Western Europe

By PAUL DAMIRON, President
Damiron Corp.
New York, N. Y.

. . . . increasing emphasis on strip and sheet is one of the more pronounced trends in Western European steel production . . . .

▲ BEFORE presenting any figures concerning the development of the steel industry in Europe, and although most of you, through your travels and from the various reports you have received, are familiar with the general conditions prevailing abroad, I think that a few typical figures might be interesting for comparison between the economic conditions in Europe and the U.S.A. I will compare, for example, the U.S.A. with France:

In the U.S.A., there are roughly 30 million automobiles as against one and a half million (or 5 per cent of the U.S. figure) in France. In the U.S.A., there are roughly 2 million tractors as against 35,000 in France, which is 1.75 per cent of the U.S. figure. In the U.S.A., the annual consumption of electricity is around 200 billion kwhr as against 18 billion in France, which is 9 per cent of the U.S. figure. In the U.S.A., there are about 25 million telephones as against 1,800,000 in France (or 7 per cent of the U.S. figure). In the U.S.A., while you produce around 21 million metric tons of strip, sheet and tinplate per year, the French mills roll about 700,000 metric tons (or about 3 per cent of the U.S. figure).

The fact that France averages 2 to 10 per cent of the U.S. figures for such important and typical items of industrial development as sheet steel production, electricity, telephones, automobiles and tractors, and since its population, (French colonies not included), is 28 per cent of the population of the U.S.A., indicates roughly that one U.S. citizen, for the items considered, uses the quota allowed to five Frenchmen.

What applies to France applies to other Western European countries with a small plus or minus factor and, bearing this in mind, we can have a better understanding of the conditions of the strip, sheet and tinplate industries in Europe.

Presented before AISE Cleveland District Section Meeting, November 15, 1948

STRIP, SHEET AND TINPLATE IN FRANCE

Strip—At the present time in France, the denomination "strip" (French: feuillard) applies chiefly to narrow widths: 20 in. and under. This material is rolled up to 10-12 in. wide on a few continuous merchant mills, and up to 20 in. wide on a very few German combination mills which are generally equipped with double-duo stands for finishing. The production of some American mills, to a great extent, is reserved for sheet bars, and their strip production is therefore small in tonnage. The weight of the coils is also limited generally to less than 70 lb per inch of width.

Only one French built reversing hot mill is capable of rolling strip up to 60 in. wide in comparatively heavy coils, but for various reasons, the production of this mill is very limited and thus affects the tonnage statistics to a very small extent.

As an exception, there is a French plant that produces coils of strip up to 66 in. wide by welding together hot rolled sheets about 0.12 in. thick and 40 to 50 ft long produced on a 3-high hot mill. These coils are further cold rolled in a 72 in. reversing 4-high mill of American design. The production of this installation, unique in its kind so far as we know, is used by one of the most important automobile works in France, both for autobody and for various deep drawing applications. Its production is about 5,000 to 6,000 metric tons per month.

Other exceptions are two French plants which weld hot rolled sheets of about 0.12 in. thick and 30 to 42 in. wide in loops or coils with subsequent cold rolling in special type mills. We call these "exceptions" as the strip obtained does not exactly conform to the American strip standards.

Sheet—The demand for steel sheets in France for all thin gages (14 to 29) is satisfied (outside of the excep-

tions mentioned in the strip program) by about 25 plants equipped with old style 2-high mills with occasional 3-high sheet bar roughing stands. Some of these mills are mechanized and these reach the same production per stand as those obtained in the U.S. (about 100 to 120 net tons per finishing stand per 24 hours in galvanized stock).

Three 4-high cold mills of American design and a number of 2-high finishing cold mills are used for cold rolling sheet by sheet to improve the surface as required by the automotive, furniture, household, etc., industries.

Tinplate—Nine tin mills in France produce tinplate by the Welsh method starting from sheet bars hot rolling in two-high mills, cold rolling in tandem two-high stands. All this tinplate is hot-dip coated in Welsh or American type tinpots. A very small tonnage of narrow strip (less than 8 in.) is cold rolled in special type cold mills and continuously tin coated by the hot-dip process.

The strip, sheet and tinplate rolled in France for all gages (14 and under) in a typical pre-war year (1938), reached a production of about 700,000 metric tons, of which 270,000 are rolled in the eastern part of France, 220,000 in the north, 85,000 on the Atlantic coast, and the remaining 125,000 in various locations chiefly in the center of the country. Out of these 700,000 metric tons, tinplate represents about 125,000 metric tons or 17 per cent of strip, sheet, and tinplate which is not very far from the American proportion.

A very interesting figure for comparison between the U.S.A. and France is the ratio between the production of flat rolled products (strip, sheet and tinplate) and the production of all hot rolled products (shapes, bars, rails, etc.). This ratio is around 35 per cent in the U.S.A. and around 17 per cent, or about one-half, in France.

The sheet and tinplate production of France was found to be insufficient in the pre-war years, and between 1937 and 1939 an important number of French sheet and tin mills studied plant modification in view of meeting greater tonnages.

In 1939, the first mechanized sheet mill was started. Then, in 1944, a second mill and a single stand hot strip mill were started. The post-war program was centered on the mechanization of existing sheet mills and on strip rolling—most of the modern sheet mills (3-high and 2-high) are already completed and in production. Concerning strip, the program includes:

One 66 in. continuous hot strip mill to be installed in the north of France, one-66 in. three-stand tandem cold mill for sheets to be installed close to Paris and one or two four-high, single stand, reversing cold mills for tinplate to be installed on the Atlantic coast. When these mills start operation sometime in 1950, they will add 600,000 to 700,000 metric tons per year to the French flat rolling capacity. Some of the existing four-high cold mills of American design already mentioned and presently cold rolling sheet by sheet will, at that time, be equipped with coilers and will cold roll strip as reversing mills. The hot and the cold rolling capacities will be normally balanced at that time.

All this equipment is of American design and, for the most part, of American construction, some of which has already been delivered. All the auxiliary equipment including pickling, cleaning, shearing, etc., is of American design and was constructed in the U.S.A. The electrical equipment is of the American type and chiefly of American construction.

An additional installation including another continuous hot strip mill 80 in. wide, one 5-stand, and one 3-stand tandem cold mill and also electrolytic tinning equipment to be erected in the eastern part of France, will soon be ordered in the U.S.A. This installation would represent an additional rated capacity of about 800,000 metric tons per year.

If all these new installations are completed around 1952, France will offer a well-balanced ratio between its total rolling capacity and its strip, sheet and tinplate

Figure 1 — Map illustrates strip, sheet and tinplate production in France in 1938. Circles on maps are drawn so as to be proportional to tonnage.

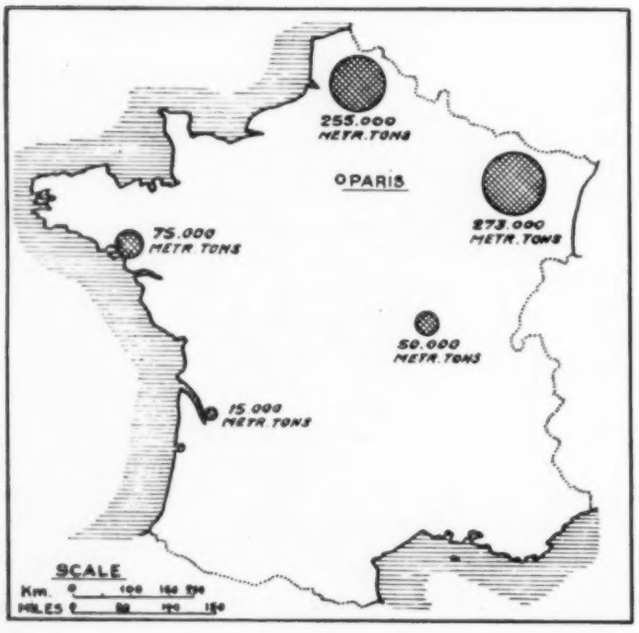
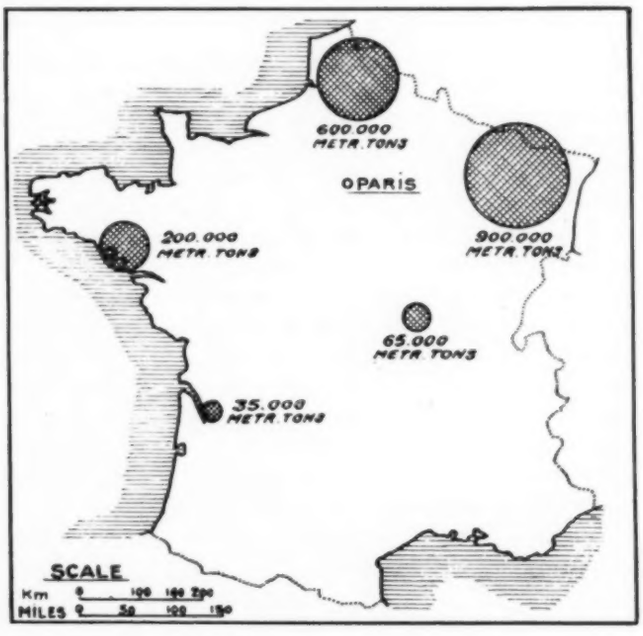


Figure 2 — The probable capacity in 1950 in France for sheet, strip and tinplate are illustrated in the sketch.



rolling capacity. This ratio, taking into consideration a modernization and a certain increase in capacity of some of the bar and structural shape mills, will eventually reach, at that time, the 35 per cent figure now existing in the U.S.A.

The utilization of these thin gage, flat rolled products which are, in the U.S., roughly 50 per cent for the automobile industry, 25 per cent for tinplate, 10 per cent for furniture and household uses, and 15 per cent for the rest, will probably have to be different in a country like France which offers a different degree of industrialization. And this is a delicate problem.

The study of this particular incidence of the development of the strip, sheet and tinplate facilities on the industrialization of a country is a matter of great importance, and extensive planning must be prepared in order to provide a well-balanced economy. This applies more especially to France which does not figure amongst the great steel exporting countries and which balances most of its various productions in its internal economy.

STRIP, SHEET AND TINPLATE IN BENELUX

Before the war, Belgium and Luxemburg were great exporters of steel products: profiles, rails, bars, sheet bars, plates, sheets, galvanized and silicon sheets. Their production was exported to the extent of 75 per cent for Belgium and more than 90 per cent for Luxemburg.

The sheets produced in Belgium were hand rolled in the usual two-high mills with only two or three mechanized three-high sheet bar roughing mills and perhaps the same number of mechanized two-high finishing stands. It must be noted that the Belgian workmen in these old style sheet mills were setting excellent production records, and undoubtedly this country had the advantage of having hard working men in plants run by clever and "very careful with expenses" management. Thus, their cost prices were probably, before the war, the best in all western Europe for many categories of sheet, including specially galvanized stock. This permitted them to sell on the great export markets against any other competitors.

In 1929, the year of maximum production in most of the western European countries, Belgium produced 228,000 metric tons of sheet. In 1938, the production of sheets dropped to 177,000 metric tons. It is important to note this fact as the year 1938 is generally taken as a basis for comparison—for Belgium and Luxemburg especially, it was a very bad year. At this time, there was included in the latter figure a small tonnage of tinplate produced by the hot rolling and hot-dip method (around 4,000 metric tons in 1939). Included, also, in the sheet production were about 8,000 metric tons of high quality silicon sheets produced by a highly reputed Belgian sheet mill. For strip, the production in Belgium in 1938 was 122,000 metric tons (narrow strip under 20 in).

Before the war, Luxemburg produced a comparatively small tonnage of sheets mainly black and galvanized, and no tinplate. This tonnage was about 60,000 to 80,000 metric tons per year.

The same remarks made regarding the excellent cost prices obtained by the Belgian sheet mills applies to the Luxemburg mills as well. This country, probably exporting a higher percentage than any other country in the world (90 per cent or more of their total steel capacity), had amongst other things, the great benefit of low taxes. The high standard of their steel industry, due to the efficiency of the management and the ability of the workmen, has always been acknowledged.

Holland was chiefly, in the pre-war years, a pig iron producer with only one sheet mill equipped with mechanized mills which produced a small tonnage of black sheets, mainly for barrel stock. This mill produced around 30,000 metric tons per year.

These three above mentioned countries, now grouped for economic purposes under the denomination of "Benelux," have faced the post-war reorganization problem of their steel industry in a very matter-of-fact way with a view to satisfying the demands of their domestic and export markets.

Directing their major efforts in the direction of flat rolled products, they are already constructing some important installations. In Belgium, these include one 56 in. semi-continuous hot strip mill, one sheet cold rolling plant with special type cold mills, and one sheet and tinplate cold rolling plant including reversing mills and electrolytic tinning. This represents a rated capacity of 250,000 to 300,000 metric tons per year. Two other projects are under consideration and include continuous or semi-continuous or reversing type hot strip mills with widths to be between 24 and 66 in. and with eventual cold rolling and finishing facilities. All this equipment is of American design and the rolling mills, auxiliary and tinning equipment are of American construction throughout.

In Luxemburg, a combination plate and strip mill 60 in. wide, with the necessary cold rolling and finishing facilities through reversing mills, is under construction, and will add 200,000 metric tons annual capacity to the sheet production of that country. This equipment is of American design and construction, including mills and auxiliaries. Holland may follow with some strip mill installations.

It is interesting to note that Belgium and Luxemburg are planning these new installations with the constant aim of maintaining their "quality and low-cost price" policy necessary for export markets, and they are using American methods with necessary adaptations to their comparatively smaller tonnages. Great attention is devoted to tonnage problems and the new units are designed to operate, in all probability, close to their rated capacity. When these new installations start producing in 1950 or 1951, "Benelux" will represent a fairly important and a highly competitive group on the international market of strip, sheet and tinplate.

STRIP, SHEET AND TINPLATE IN GREAT BRITAIN

Before the war, Great Britain was the most advanced country of all Europe (including even Germany at the time) as far as the production of strip, sheet and tinplate was concerned, second only to the United States.

Exporting part of this production, Great Britain was, in 1937, responsible for 50 per cent of the world's total exports of tinplate.

A considerable number of sheet and tin mills, most of them in Wales, others in the Midlands and in the Middleborough vicinity, were rolling, in the years 1936-39, close to one million metric tons of sheet plus close to one million metric tons of tinplate. A few of these old style mills were mechanized (3-high and 2-high). In 1935, these mills, even though manned by exceptionally skillful men who represented the old British tradition and grouped in the hands of world-famous firms, were not found by their owners to be producing sufficiently high-quality products and at sufficiently low-cost prices to compete on the great international market, and England decided to go in for wide strip.

Successively, at Ebbw Vale in South Wales and in Shotton, two 50 in. straight American type continuous hot strip mills were installed with the necessary cold mill and finishing facilities, including a five-stand tandem tinplate cold mill at Ebbw Vale.

Immediately after the war, an electrolytic tinning line was started also at Ebbw Vale. The British capacity in sheet and tinplate was, at this time, increased by nearly 50 per cent compared with the figures quoted above. All this equipment, such as rolling mills, finishing and electro-tinning equipment, was of American design and chiefly of American construction.

In spite of all these developments, they did not reach the production expected, and in 1945 an entirely new unit was designed and is now under construction: At Port Talbot in South Wales, an existing blast furnace plant will get an additional furnace and alterations will be made on the existing ones. This plant will be followed by new steel works, an 80 in. continuous hot strip mill (scheduled for more than one million metric tons annually), and a 3-stand tandem cold mill for sheets.

Not far from this installation, a cold mill plant is to be erected at Llanelly which will include a 5-stand tandem cold mill for tinplate and electroplating facilities. Some other cold mill facilities are also planned in the nearby Swansea district.

It is significant to see, after the hardships of a long war, that a scheme of such magnitude has been planned and is in the process of being erected in Great Britain. We had the privilege of visiting the Port Talbot site early this summer, and we found that the way in which the plant had been designed, reflects a perfection and a grandeur in line with the great British manner.

In 1951 or 1952, England should produce up to about four million metric tons per year in sheet and tinplate, with the latter figure representing more than 1½ million metric tons.

At that time, out of a hot rolled steel production of perhaps 12 million metric tons, the percentage of strip, sheet and tinplate will be in the neighborhood of the 35 per cent indicated earlier as now existing in the U.S.A. The British industry, plus their export markets, can undoubtedly keep such a production program close to its rated figure.

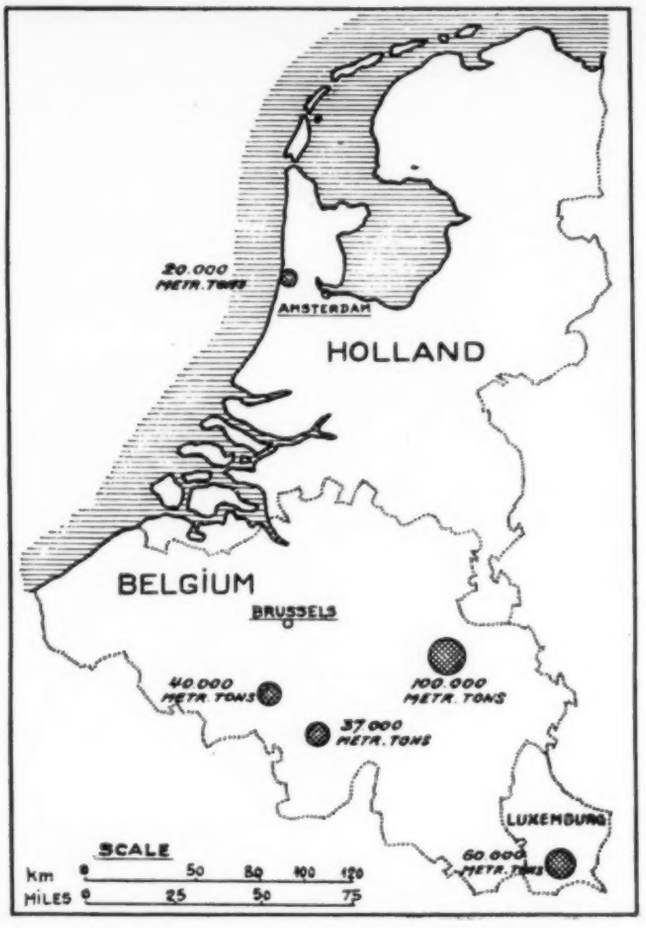


Figure 3 — Map illustrates strip, sheet and tinplate production in Belgium, Holland, and Luxemburg in 1938. Note scale of this map is larger than that of Figures 1 and 2.

STEEL INDUSTRY IN WESTERN EUROPE

We will terminate this paper by indicating some figures relating to steel production in western Europe.

Europe is not producing as much steel as its ore facilities permit, because Europe is lacking in coke and we assume this is true even if there is some controversy on this point. In fact, if the post-war programs of the various countries are to be realized, western Europe needs, in 1951, a 50 per cent increase in the coke used in 1947. The reduced production of the Ruhr is one of the contributing factors to this problem; in 1936, out of a total western European production of 480 million metric tons of coal, the Ruhr produced 107 metric tons or 22.4 per cent. In 1948, it is estimated that the total coal extracted will be in the neighborhood of 400 million metric tons with the Ruhr accounting for 80 million metric tons or only 20 per cent of this total.

Some of the figures given for these post-war programs are as follows in ingot tons:

Britain's aim for 1953 is to produce 17 million metric tons of steel.

France's aim for 1951 is to produce 12½ million metric tons of steel.

Belgium for 1951 expects to reach 5 million.

Luxemburg for 1951—3 million.

Italy for 1951—3 million.

Sarre Basin for 1951—1¾ million.

Sweden for 1951—1½ to 2 million.

Germany may produce in 1951, 10 million metric tons.

(The Ruhr, which produced 13 million tons of steel in 1937, is expected to reach 5 million in 1948).

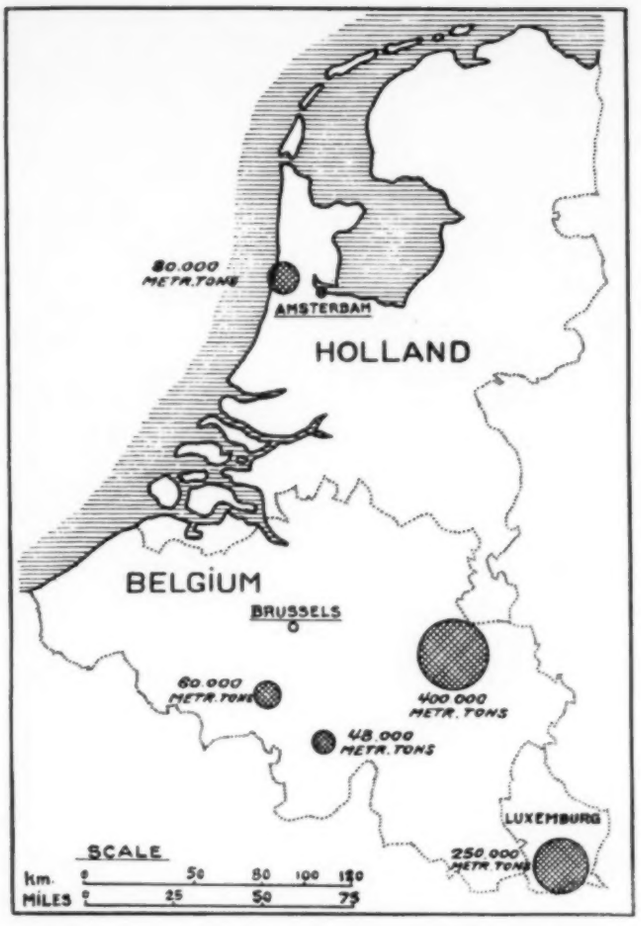


Figure 4 — The probable capacity in 1950 in Belgium, Holland and Luxemburg is illustrated in the sketch.

Spain for 1951—⅔ million.

Norway for 1951—¼ million.

Altogether, this represents with a plus or minus factor for all future programs, 55 million metric tons per year as against 46 million in 1936, still very low in regard to the population concerned.

The realization of these productions will necessitate, for the period 1947-51, expenditures for equipment estimated at 400 million U.S. dollars. A considerable part of this equipment is to be of American design and an important part of American construction.

Since the end of the war, the principal western European steel producing countries, and more specifically Britain, France and the Benelux (placing them according to their steel production) are making a considerable effort to increase their strip, sheet and tinplate production. An important number of strip rolling mills, with their finishing equipment, are already under construction.

American equipment and the American methods will be used to hot roll, cold roll, process and coat the strip in these future installations. However, certain adaptations of these methods and equipment must be made to meet European conditions, mainly small orders and small yearly production.

The American influence on the art of rolling, processing and coating the strip is dominant, and American aid is essential to Europe for the rapid construction of the new plants.

The rapid development of strip steel production affects, to a great extent, the whole economy of the countries concerned. The U.S.A. met these conditions and has been highly successful. We think that, through careful study and precise planning, the same success can be, and will be, obtained in western Europe.

DISCUSSION

PRESENTED BY

CLAYTON T. ELDER, Industrial Sales Engineer, Cleveland Electric Illuminating Co., Cleveland, Ohio

A. R. Geiszler, Application Engineer, Wean Engineering Co., Warren, Ohio

R. J. WEAN, President, Wean Engineering Co., Warren, Ohio

JAMES C. ADDLEMAN, Application Engineer, Steel Mill Section, Westinghouse Electric Corp., Cleveland, Ohio

J. S. APPERSON, III, Application Engineer, General Electric Co., Cleveland, Ohio

ELI SHAY, Electrical Engineer, Wean Engineering Co., Warren, Ohio

GEORGE S. MONKS, Resident Engineer, Otis Works, Jones & Laughlin Steel Corp., Cleveland, Ohio.

PAUL W. MILLER, Wean Engineering Co., Warren, Ohio

Clayton T. Elder: Is the new mill to be located on the Atlantic coast in France?

Paul Damiron: In France.

A. R. Geizler: You mentioned that the present steelmaking facilities were not operating at their rated capacities due to the shortages of coke. Is there any energetic program under way to increase the coke producing facilities?

Paul Damiron: There are some programs which are not very extensive. They depend too much on mining production, and mining production in Europe is such a difficult problem to deal with that people hesitate to build new installations of coke oven furnaces because they are never very sure of getting the right coal in the right amount.

Most of our mines are not capable of producing good coking coal for the steel industry. The biggest part of the coke used in the French steel industry came from the Ruhr before the war, and those mines, because of the war, have been more or less damaged, so that now the Ruhr cannot give to Western Europe the same amount of coke that was delivered before.

It is very difficult to increase coal mining production. Some European mines like the Belgian mines produce a very good coking coal, but they are very deep and so it is very difficult to increase to any great extent their production. We cannot expect the Ruhr to produce as much coke as before the war for some time yet.

A. R. Geizler: How then do they propose to meet the increased steel requirements?

Paul Damiron: There has to be some importation of coal and of coke.

R. J. Wean: I think it might be well if Mr. Damiron would deal with the prewar German capacity and its present capacity to show that probably a fair amount of the Benelux program may be to supply the markets that were formerly supplied from Germany.

Paul Damiron: What Mr. Wean says is certainly very true. There is a real need of production in Europe, which was fulfilled before the war by Germany and now the Benelux steel industry is working very hard to get the market and they are very good at that.

It will probably be a number of years before Germany will be able to start their pre-war production again. In the meantime, it will be necessary for somebody to take her place, and Belgium and Luxemburg are in an ideal position to do that. They expect, I suppose, to take as much of that market as they can.

R. J. Wean: Do you know the prewar capacity of Germany?

Paul Damiron: The prewar capacity of Germany for steel production was around 20,000,000 tons. If I am correct, the highest production was in 1943 with 30,000,000 tons of steel. That was the maximum war output of Germany with all its industrial strength at that time, which was at its peak.

As far as sheet capacity and strip capacity are concerned, Germany was never on a very high production level. She was always far behind Britain. There was only one continuous wide strip mill built and operating just before the war. That was in Dislaken, Germany, and it was a 50 in. continuous strip mill, built according to American design by a German builder. This mill, as far as I know, has been dismantled and taken by Russia.

Just before the war, another mill was ordered for hot rolling strip in Germany by Hoesch in Dortmund, and that was a 4-high reversing hot mill. This mill was to start in 1939, but was, for various reasons, used as a plate mill. A report I had this last summer from Germany indicates that this mill at Hoesch is now producing narrow strip and is said to be working very nicely.

R. J. Wean: What is the present postwar figure for Germany that has been agreed upon?

Paul Damiron: They said they hoped to make 10½ million metric tons of steel in 1951 if everything goes all right.

Member: These five countries started their expansion programs before talk of the Western Union, because of the Russian situation, had become prevalent. I wondered if that Western Union they are speaking about affects the expansion programs in the individual countries. Will there be an attempt to coordinate the expansion now?

Paul Damiron: Yes, to a small extent. Each country likes to make its own program, and if this program fits in the scheme, that will be all right. If it doesn't fit, well, nobody knows what will happen.

James C. Addleman: You spoke of about two and a half million tons for the Ruhr. Is that not a very small percentage of the potentialities that can be produced in the Ruhr under a large expansion program?

Paul Damiron: I said the Saar Basin production might be between 1½ and 2½ million tons. I have put the Saar Basin separately because, as you know, the Saar Basin is somewhat economically separated from the rest of the country around it now. The Saar Basin is expected to make about 2 million tons of steel. If Germany expects to make 10½ million, at that time the Ruhr may make 60 or 70 per cent of that total.

J. S. Apperson: This may or may not be on the subject, but we notice a shift toward fabricated machinery in this country. Is the same shift going on in Europe and is that affecting the amount of sheet production in the expansion program?

Paul Damiron: You mean because of welded construction?

J. S. Apperson: Yes, in cases when making heavy machinery the manufacturer uses welding to make up the machine instead of using castings or other procedures. This may have some effect on flat sheet production.

Paul Damiron: Yes, I think it is one of the uses which might be expected, and it is one of the trends which might be modified by the increasing production of heavy gage sheets.

Eli Shay: Mr. Damiron, you have given us detailed information about Western European production. Can you give us any information about Russian steel production?

Paul Damiron: That is a very difficult question. I do not know much about the production of Russia, but according to some printed data, it might be in the neighborhood of 25 or 30 million tons of steel. However, I really have no data which permits me to give you that figure as a statistical figure.

Member: I want to know what increase there is in France and in Europe in general steel making capacity in comparison with your doubling or tripling of the strip making capacity.

Paul Damiron: Both capacities, the total steel capacity and the strip capacity will probably not go the same way. If we expect to have a greater increase in strip capacity than in steel producing capacity, that will mean we will produce probably not much more structural shape and steel castings than now but will make much more strip.

George S. Monks: Is it expected that the automobile industry, the tin canning industry, and that furniture and refrigerators and the like will expand extensively?

Paul Damiron: I do not believe that there will be such a big development in the automobile industry in Western Europe. The automobile industry is always a limited field in Europe. Just as I was saying, we have not sufficient money to have all the facilities the U. S. citizens have, and one of the principal things that we do not use much in Europe are automobiles. There are still a lot of people riding on bicycles and not so many in automobiles.

I think, however, that steel furniture is something that will expand considerably in Europe, as well as windows and window frames, which are now made of wood only, will be made of steel to as great an extent in Europe as they are now in the U.S.A.

Refrigerators are considered by most Europeans as a deluxe item and they are quite expensive. Only people of high social rank have refrigerators. So I do not expect that there will be any large market for them.

Paul W. Miller: What are the sources of iron ore for

the various Western European countries, and how does this affect the general price structure?

Paul Damiron: We have a considerable amount of iron in Europe, although most of it has a very poor iron content. It varies between 20 and 32 per cent Fe, and that is very low compared to the percentage in U. S. ores of about 55 per cent.

We have two grades of ore. One is acid and the other is basic, both with approximately the same content of Fe. By mixing these two ores in the right proportions, we avoid the use of a great quantity of lime in the blast furnace, and then we save in the cost of the pig iron produced so that finally we can get a pig iron at a good cost if coke consumption is reasonable. This pig iron has phosphorus and we treat it in the so-called Thomas converters, which is a basic type of converter. The steel produced is a very good grade of steel for most applications, except perhaps for deep drawing purposes. In Spain, there is a very fine hematite ore with 50 to 55 per cent Fe.

Also, in French Algeria, in North Africa, we have very good ore with 55 per cent Fe.

Paul W. Miller: Western European countries then import very little of their ore?

Paul Damiron: Yes, because they do not need it. I must also mention that in Sweden they have the best iron ore of Europe that is reserved for the production of high class steels, and this ore, apart from its use in Sweden, was exported before the war, mainly to Germany and Czechoslovakia.

Paul W. Miller: You said refrigerators and so forth were regarded as luxuries in France and Western Europe, what is the comparative cost of power in France compared to the States per kilowatt hour or on any other basis?

Paul Damiron: It is very difficult for me to give you a comparative figure, because there have been many fluctuations in price and in currencies. Pre-war the kwhr was sold in France at 1.50 franc, now it is 18 francs.

Clayton T. Elder: I would like to ask Mr. Damiron about the type of steel I understand from what you said about blowing the iron that most of the steel is bessemer steel.

Paul Damiron: At least a good proportion of it is a basic bessemer. It is the so-called Thomas steel, and that is produced in a bessemer converter but with a basic lining in order to make a highly phosphoric slag, which gives a steel with a minimum of phosphorus, starting from a phosphorus pig iron.

Paul W. Miller: Do they use the open hearth to any extent in France?

Paul Damiron: Yes, open hearths are running, and they use a high percentage of scrap. In other words, there is usually 25 per cent of pig iron, sometimes up to 30, and the rest is scrap. They are the usual type of basic open hearth, a few only are acid, chiefly of small capacity, 50 or 60 tons. Still there are a few 30 to 40 ton furnaces.

Member: You mentioned that they were using a 4-high cold mill they had taken out. What would you say would be the speed they would obtain in France? Would they handle anything like we handle here, which is around 5000 ft a minute in this country?

Paul Damiron: So far, you can practically say that we have in Western Europe, England excepted, no real cold mill rolling strip because the only ones we have working are in such bad condition that they work at very low speed. But I expect that we will have high figures in the near future because the French, Belgium and Luxemburg steel industries have ordered the very best make of American type mills and equipment, and we have been careful about getting the latest types and the highest speeds.

Member: I noticed in several cases you made reservations, you said "with modifications." Does that indicate they are not going so much to electronic control and so forth or so on, or lower speed?

Paul Damiron: As far as the controls are concerned, I should say that every new mill ordered will come with the latest American control.

Member: Is there going to be any attempt at cutting down the labor with these mills?

Paul Damiron: We have a tendency to reduce labor as well as anybody else, but such a reduction, for the simple reason that the cost of labor, which is one-quarter of what it is here, is not so important. The tendency is still to cut down on workmen because we think that if we use high class machinery we can use the men for something else.

There is a demand for copies of the following Yearly Proceedings:

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ASSOCIATION OF IRON AND STEEL ENGINEERS, 1010 EMPIRE BLDG., PITTSBURGH 22, PA.

1949 Annual Convention

WILLIAM PENN HOTEL

PITTSBURGH, PA.

OCTOBER 3, 4, 5 and 6

Tentative Program

Monday, October 3

9:00 a.m. — REGISTRATION—Fort Duquesne Room

9:00 a.m. — LADIES' REGISTRATION AND HEADQUARTERS — Parlor E-F

9:15 a.m. — BUSINESS MEETING — Urban Room
Conducted by President C. H. Williams

9:30 a.m. — ELECTRICAL SESSION — Urban Room

Chairmen: J. D. O'ROARK
Weirton Steel Co.
J. H. FRANZ
Carnegie-Illinois Steel Corp.

"The Mill Motor After 45 Years," by S. S. Burns, Crocker-Wheeler Electric Manufacturing Co., Division of Joshua Hendy Corp.

"Cold Rolling of Tinplate," by G. E. Stoltz and J. W. Brinks, Westinghouse Electric Corp.

9:30 a.m. — COMBUSTION SESSION — Monongahela Room

Chairmen: H. S. HALL
Lukens Steel Co.
E. T. W. BAILEY
Steel Company of Canada, Ltd.

"Automatic Combustion Control for Steel Mill Boiler Plants" by M. J. Boho, Hagan Corp.

"Status of Open Hearth Controls," by B. B. Bargman, Carnegie-Illinois Steel Corp.

"Experience in Oxygen Flow Measurement," by C. W. Parsons, Republic Flow Meters Co.

ALL EVENTS WILL BE HELD ON THE 17th FLOOR OF THE WILLIAM PENN HOTEL

2:00 p.m. — ELECTRICAL SESSION — Urban Room

Chairmen: A. D. HOWRY
Alan Wood Steel Co.
R. L. LIVINGSTON
National Tube Co.

"Design and Maintenance of Crane Runways," by V. L. Smith, Fort Pitt Bridge Co.

"Recent Developments in the Design of Coal and Ore Bridges," by B. A. Rose, Heyl and Patterson, Inc.

"Sliding Contacts for Transfer of Electrical Energy for Industrial Systems," by H. Yale Mageoch, Electric Service Manufacturing Co.

2:00 p.m. — ROLLING MILL SESSION — Monongahela Room

Chairmen: JAMES N. IMEL
Jones and Laughlin Steel Corp.
CHARLES HAMMOND
Rotary Electric Steel Co.

"Rail Slitting Mills," by C. W. Barrett, Republic Steel Corp.

"Continuous Merchant Mill," by L. C. Sowell, Jones and Laughlin Steel Corp.

"Pass Design for Angular Sections," by Ross E. Beynon, Carnegie-Illinois Steel Corp.

3:30 p.m. — LADIES' TEA AND RECEPTION — Fort Pitt Room

Tuesday, October 4

9:00 a.m. — COMBUSTION SESSION — Monongahela Room

Chairmen: C. E. DUFFY
Bethlehem Steel Co.
GEORGE H. KRAPF
Carnegie-Illinois Steel Corp.

"High Speed Heating and its Implications for the Steel Industry," by Frederic O. Hess, Selas Corp. of America.

"Construction and Maintenance of Open Hearth Furnace Bottoms," by C. William Conn, Ford Motor Co.

"Checker Brick Design, Construction, and Use," by Jay J. Seaver, Jay J. Seaver Engineers.

9:00 a.m. — STANDARDIZATION SESSION — Urban Room

Chairmen: FRANK CRAMER, Chairman
AISE Standardization Committee
L. J. GOULD
Bethlehem Steel Co.

"Standardization Report," by F. W. Cramer

"Final Report of AISE Crane Wiring Standardization Committee," by C. G. Dimitt, Co-Chairman, AISE Crane Wiring Standardization Committee.

"Progress Report of AISE-NEMA Committee on Brake Standardization," by V. E. Schlossberg, Chairman, Joint AISE-NEMA Committee on Brake Standardization.

"Report on Carbon Brush Standardization," by Hugh Conover, Chairman, Carbon Brush Standardization Committee.

"Specification for Design of Ladle Hooks," by William H. Mursch, Chairman, Design of Ladle Hook Committee.

11:30 a.m. — LADIES' LUNCHEON
(Meet at Ladies' Headquarters)

1:30 p.m. — INSPECTION TRIP TO IRVIN WORKS, CARNEGIE-ILLINOIS STEEL CORP.

6:00 p.m. — OLD TIMERS' DINNER — Fort Pitt Room

Wednesday, October 5

9:00 a.m. — ELECTRICAL SESSION — Urban Room

Chairmen: V. E. SCHLOSSBERG
Inland Steel Co.
R. W. GRAHAM
Bethlehem Steel Co.

"Supervisory Control and Telemetering as Cost Reduction Tools," by E. Wylie Head, Control Corp.

"A Static Amplifier for Regulating Circuits," by H. E. Larson and T. Dunnegan, Jr., General Electric Co.

"The Mechanical Rectifier," by Otto Jensen, I-T-E Circuit Breaker Co.

9:00 a.m. — MECHANICAL SESSION — Monongahela Room

Chairmen: EMIL KERN
Allegheny Ludlum Steel Corp.
P. L. WALTER
Republic Steel Corp.

"Steel Plant Maintenance," by S. D. Baumer, Air Reduction Sales Co.

"Mill Building and Equipment Painting," by Warren W. Scherer, Carnegie-Illinois Steel Corp.

"Couplings for Rolling Mill Drives," by W. P. Schmitter, Falk Corp.

1:00 p.m. — GENERAL SESSION — Ball Room

Chairmen: C. H. WILLIAMS
Carnegie-Illinois Steel Corp.
A. S. GLOSSBRENNER
Youngstown Sheet and Tube Co.

An address by M. W. Reed, Vice-president, engineering, United States Steel Corp.

2:00 p.m. — MATERIAL HANDLING SESSION — Urban Room

Chairmen: R. P. TOOKE
Armco Steel Corp.
T. M. FAIRCHILD
Bethlehem Steel Co.

"Materials Handling in a Steel Plant," by L. Russell Astie, Jones and Laughlin Steel Corp.

"Relation of Material Handling to Production," by James S. Freese and Frank C. Wier, The Timken Roller Bearing Co.

"Developments in Coil Conveyor Equipment Design," by L. O. Millard, Link Belt Co.

2:00 p.m. — LUBRICATION SESSION — Monongahela Room

Chairmen: C. E. PRITCHARD
Republic Steel Corp.
A. CICHELLI
Bethlehem Steel Co.

"The Action of Cutting Fluids in Machining," by Dr. M. Eugene Merchant, The Cincinnati Milling Machine Co.

"Steel Plant Lubrication Training," by William M. Schuck, Armco Steel Corp.

"An Evaluation of Oil Purifiers for Steel Mill Service," by J. I. Clower, University of Delaware.

Thursday, October 6

9:00 a.m. — OPERATING PRACTICE SESSION — Urban Room

Chairmen: P. E. HAGLUND
Ford Motor Co.
R. H. GELDER
Armco Steel Corp.

"Reviewing Progress in Pressure-Blowing Blast Furnaces," by Frank Janecek, Republic Steel Corp.

"Increased Open Hearth Production by Improved Charging Methods," by R. Tietig, Jr., A. J. Boynton and Co.

"Controlled Cooling of Steel Blooms in Car-Bottom Furnaces," by C. J. F. Burch, Carnegie-Illinois Steel Corp.

9:00 a.m. — LUBRICATION SESSION — Monongahela Room

Chairmen: D. N. EVANS
Inland Steel Co.
R. A. KRAUS
Republic Steel Corp.

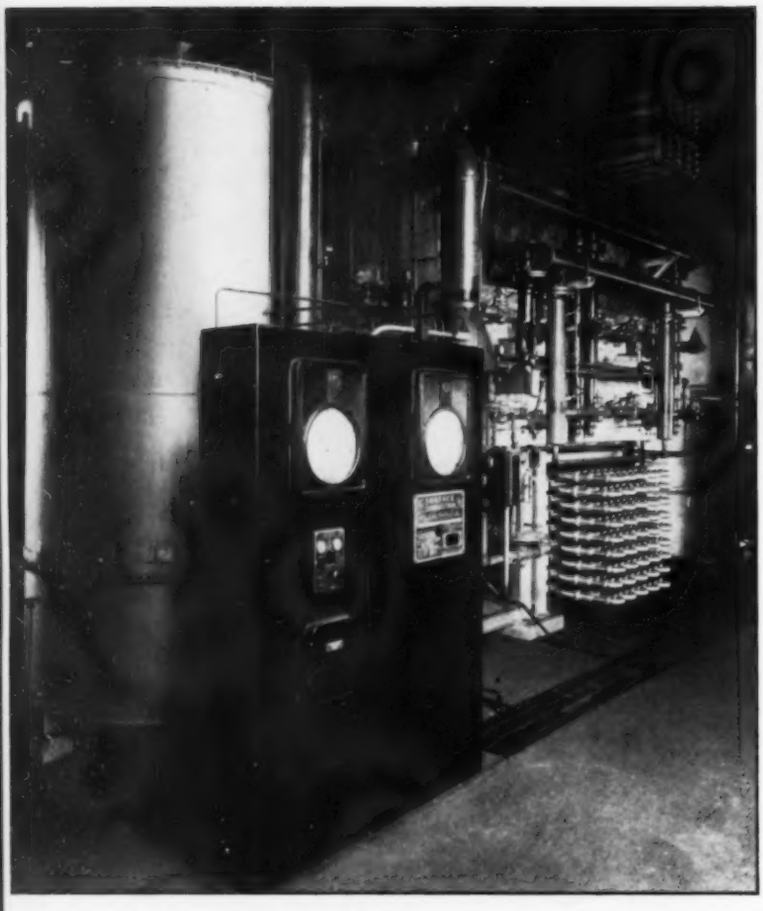
"Considerations in the Development of Roll Neck Oil Seals," by Edw. W. Fisher, Garlock Packing Co.

"Bearing Inspection and Repair," by C. T. Lewis, Republic Steel Corp.

"Relationship of Preventive Maintenance and Roller Bearing Application," by J. A. Toth, The Torrington Co. Bantam Bearings Division.

1:30 p.m. — INSPECTION TRIP TO ALIQUIPPA WORKS, JONES AND LAUGHLIN STEEL CORP.

INSPECTION TRIPS



TUESDAY, October 4

CARNEGIE-ILLINOIS STEEL CORP.

IRVIN WORKS
DRAVOSBURG, PA.

•

Buses will leave Grant Street entrance of William Penn Hotel, Pittsburgh, Pa. at 1:30 p.m., sharp.

•

Partial over-all view of one of the four controlled atmosphere generators that supply inert atmosphere gas to the annealing furnace at Irvin Works.

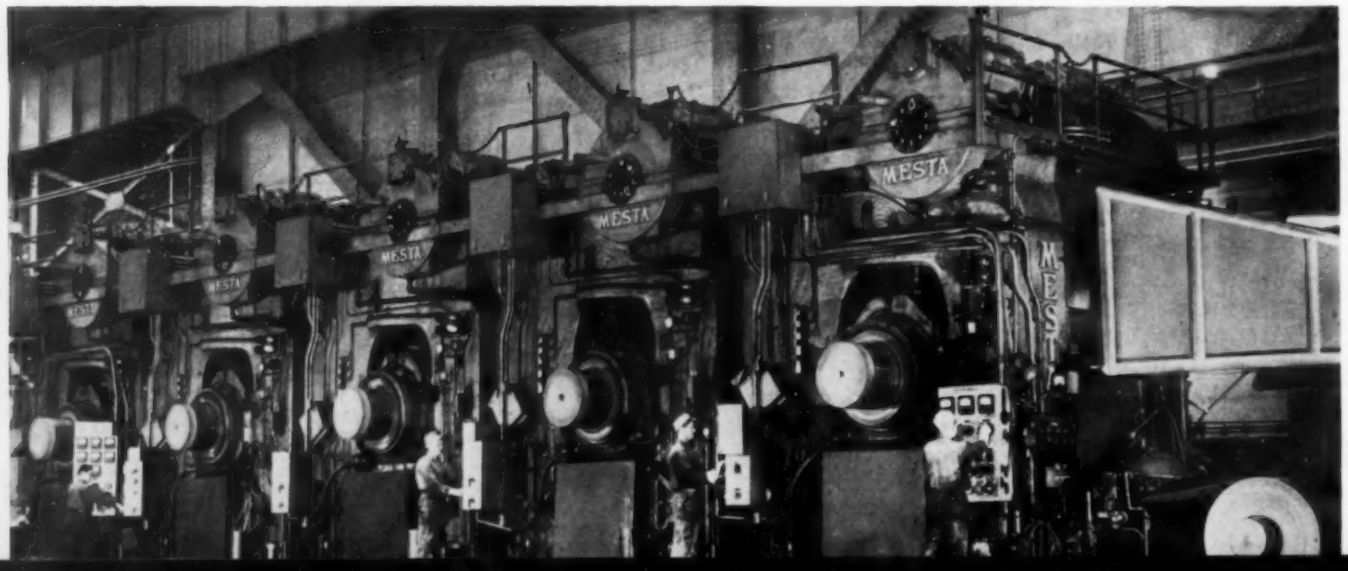
THURSDAY, October 6

JONES & LAUGHLIN STEEL CORP.

ALIQUIPPA, PA., WORKS

Buses will leave Grant Street entrance of William Penn Hotel, Pittsburgh, Pa., at 1:30 p.m., sharp.

View of the world's fastest 42 in., 5-stand tandem cold strip mill at Aliquippa Works, Jones & Laughlin Steel Corp.



TECHNICAL PROGRAM OF THE

American Iron and Steel Institute

. . . . in reviewing problems of iron and steel production, leading operators of the steel industry, at the fifty-seventh general meeting of the American Iron and Steel Institute held in New York City on May 25 and 26, presented a number of very interesting papers . . . . special panels were held on Increasing Production In The Open Hearth, Control of Sulphur in Steelmaking, Research in Steel Melting, and General Research . . . . because of their value to the industry, some of the papers are abstracted here . . .

"INCREASING OPEN HEARTH PRODUCTION BY USE OF OXYGEN, BETTER REFRACTORIES AND CONTROL OF SLAG"

by ERLE G. HILL, Director of Metallurgy and Development, Wheeling Steel Corp., Wheeling, W. Va.

▲ THERE are four major points of attack on this problem of increasing the open hearth furnace output. These are management, raw materials, refractories, and metallurgy. The latter three will be discussed. However, on the first depends the success of the others.

Assuming the furnaces are charged to capacity, the output depends largely on three factors; time of heat, the number of furnaces in active operation, and the amount of delay time.

The possibility of decreasing heat time by the use of oxygen has been of extreme interest to steel producers. As is always the case with suggested revolutionary steps in steelmaking, there have been exaggerated claims and excessive optimism. Nearly all operators have experimented with oxygen in one way or another. A great deal of money has been spent and much information gained. Some claim success, some indifferent results, and others have failed to show a monetary saving by its use. As work continues, we are sure there will be a clarification of thought and sound conclusions will be reached.

Two distinct uses for oxygen were apparent; namely, for speeding combustion of the fuel and for oxidizing the carbon in the bath. Trials of the first application required larger quantities of oxygen than did the second, so, in view of the limited supply of oxygen, much of the early work was on the use of it for decarburizing the bath. Another reason for this was the simplicity of the operation. All that was required was an oxygen supply, a heavy duty hose, and some lengths of ordinary pipe. The availability of oxygen by truck or rail greatly aided the trials.

Much has been written about this method of using oxygen and only a simple description will be given. Oxygen is usually supplied at 100 psi at the feed end of the hose. Standard lengths of cleaned pipe are used as a lance; however, a few plants use a water-cooled jet. In the case of the lance, the pipe is fed so as to keep the discharge end about 8 in. below the surface of the bath. In the case of the jet, it is not submerged, but the oxygen is blown down through the slag. The oxygen rapidly diffuses through the bath and, in a few minutes, the effect can be noticed by the rapid evolution of gas bubbles over the entire bath.

ADVANTAGES AND DISADVANTAGES

This accelerated oxidation has two distinct advantages. The more rapid carbon drop saves time. The increased bath temperature increases the fluidity of the slag, undissolved lime goes into solution, and fuel is saved. In fact, some operators find they must reduce the fuel rate during this period. Usually, less bank erosion is experienced as the banks are exposed to the high oxide slags for a shorter time.

The disadvantages are generation of fumes, splashing of the slag, which may erode the roof and front wall, and interference with charging floor operations. When

TABLE I
Variations in Use of Oxygen

Number of plants using lance	15
Number of plants using jet	1
Number of lances used simultaneously:	
Fourteen plants	1
One plant	2
Door through which lance is inserted:	
Fourteen plants	2, 3 and 4
One plant	1 and 5
Size of lance	½ to 1 in.
Feet of pipe used per heat	20 to 280 ft
Oxygen pressure at hose	50 to 175 psi
Oxygen consumed by lance:	
Cu ft per min	187 to 1000
Cu ft per ton tapped	20 to 187
Oxygen consumed by jet:	
Cu ft per min	500
Cu ft per ton	49
Maximum carbon start oxygen	0.09 to 2.50
Time between stop oxygen and tap	5 min to 1 hr-15 min
Increase in tonnage, tons per hr	0.32 to 2.9
Fuel saved, Btu's per ton	60,000 to 500,000

the oxygen is introduced at fairly low carbon content (under 0.30), fumes are not a great problem. This is also true of splashing, although it depends largely on the skill with which the lance or jet is used. Interference with floor operations is a problem that has not been solved, although experimental installations of mechanically handled jets fed through the back wall or roof are now being tried.

As might be expected, the practices used and results obtained vary greatly from plant to plant. Recently, the Technical Committee on Open Hearth Steelmaking of American Iron and Steel Institute circulated a comprehensive questionnaire among the major operators. Some of the data secured from that source have been selected to show how the practice varies.

For decarburization, sixteen plants reported on practice used on fifty or more heats. The variations shown in Table I are of interest.

The following general observations are based on these data and on information gained from talks with various operators.

The use of oxygen for decarburization is most prevalent in shops making low carbon steels. The reason for this is the normal slowing down of carbon elimination in the neighborhood of 0.12 C. Oxygen speeds up the drop at these low carbons and maintains or increases the bath temperature.

Practice in these low carbon shops has assumed a uniform pattern. One 1 in. or ¾ in. pipe is inserted in one of the middle doors. The lance is held by a movable carriage and fed at the desired rate by hand cranking. Oxygen pressure is 100 psi and is applied when the carbon has dropped below 0.30, and continued until just before tap. Increase in production is from 12 to 15 per cent. Little decrease in refractory life is reported. Fumes are not a serious problem.

Now, let us turn to the use of oxygen for the combustion fo fuel. The theory is quite simple. For the same weight of fuel burned, the use of oxygen diminishes the quantity of the products of combustion, thereby increasing the flame temperature and decreasing the amount of heat carried out by the outgoing gases. This, in turn, allows a greater weight of fuel to be burned in a given furnace in a given time. The amount of heat transferred to the bath per unit of time is thereby increased. The big advantage is the decrease in heat time, charge to tap.

In order to take advantage of this rapid heat input without damage to the furnace, the charge must be able to receive it. Cold scrap is capable of absorbing the heat as fast as it is available. Therefore, the general practice is to use oxygen during the melt-down period, or up to the addition of hot metal.

Thus, successful application of the practice entails provision for charging scrap at the rate required and for getting hot metal to the furnace at the proper stage. This may present a difficult problem to some shops as now equipped.

Referring again to the committee's report, whereas sixteen plants reported on the use of oxygen for decarburization, only nine reported on its use for combustion, on series of more than fifty heats, and only three reported its use for both combustion and decarburization.

In these cases, we again find a wide variation in practice, as the selected data shown in Table II.

TABLE II

Fuels Used with Oxygen

Fuel used	3 plants, fuel oil 2 plants, fuel oil and coke oven gas 1 plant, fuel oil, tar and natural gas 1 plant, tar and natural gas 1 plant, tar 1 plant, tar, coke oven gas, blast furnace gas
Type burner	Each plant different
Oxygen pressure, psi	40 to 200
Oxygen consumption, cu ft per ton tapped	277 to 800
Fuel saved, Btu's per ton	300,000 to 700,000
Increased production, tons per hour	0.18 to 3.90
Decreased furnace life	0 to 15 per cent

In all cases, a saving in fuel was reported and, in all but one plant, increases of 1.5 tons or more were claimed. All plants reported no lowering of steel quality.

Where special heats have been made by favoring one furnace, spectacular results have been obtained. To indicate the possibilities of increasing production by using oxygen, data on two consecutive heats made in the same furnace during early test work on the use of oxygen with fuel oil and coke oven gas are given below.

These heats were made at the Steubenville plant of the Wheeling Steel Corp. They were not the best nor the worst heats made; the furnace was favored by planned charging and special supervision. Other plants have reported better results under similar conditions. It must be borne in mind that conditions would be much different if the entire shop were operated with oxygen.

TABLE III

Data on Oxygen Test Cases

	Oxygen for Combustion and Decarburization	Oxygen for Decarburization Only
Size of heat, tons	158	162
Charge, per cent metallics		
Hot metal	60.50	58.60
Scrap	29.50	28.60
Sinter	7.70	7.50
Time charge, hr	2.00	2.30
Time finish charge to hot metal, hr	2.46	2.40
Time flush off, hr	0.45	2.00
Time charge to tap, hr	8.06	11.20
Net tons per hr, charge to tap	19.62	14.29
Gain, tons per hr	5.30	.....
Fuel		
Fuel oil, gal per ton	14.28	21.53
Coke oven gas, equivalent gal	7.53	6.71
Total equivalent gal fuel oil/ton	21.81	28.24
Fuel saved, gal/ton	6.43	.....
Maximum rate of firing, gal/hr	480	400
Oxygen for combustion, cu ft	79,766	0
Oxygen for decarburization, cu ft	16,825	12,700

The foregoing indicates that gains in production can be made by using oxygen for both decarburization and combustion. Whether or not these gains result in a saving in money will depend largely on the cost of oxygen, expense of furnace upkeep, and furnace availability.

We must point out that the tons produced per hour must be looked upon with a critical eye, unless tests have been made over a sufficiently long period that the furnace availability is taken into account. Should the furnace life be decreased too greatly, the total tonnage made in a year would be less than indicated by the test results.

One of the most difficult tasks of the open hearth operator is to prevent loss of production by failure of refractories. Both furnace repairs and furnace rebuilds rob him of steelmaking time. Delays caused by furnace repairs always result in loss of production.

On first thought, it would appear that furnace rebuilds always result in loss of production; that is, it would seem that the greater the number of heats made between rebuilds, the greater will be the yearly production. However, careful analysis may show that shorter campaigns, which maintain fast working furnaces, with fewer repair delays, may produce more tons per year than do longer campaigns, in spite of the greater number of rebuilds.

Along the same line of thought, the use of oxygen may shorten the campaign life, but, by producing greater tonnage per hour while operating, the production lost by extra rebuilds may be offset.

Although we are discussing increasing production, we cannot disregard the item of cost. In studying the effect of refractory life on production, we must also keep in mind at what cost the gain in production is made. In other words, how far can we go in decreasing refractory life by a faster rate of production before our total cost per ton of ingots increases?

A common assumption is the longer the campaign, the lower the refractory cost, and, hence, a saving in cost per ton of ingot. However, against the decrease in refractory cost must be balanced increased fuel cost, loss of production by patching, and loss of production by longer heat time as the furnace ages.

As an illustration, we will outline a study made at our Steubenville plant in an endeavor to determine the optimum campaign life.

In each open hearth shop, there is one major factor which determines campaign life. This may be maximum roof life, slag pocket size, or checker capacity. Examination of our operating data indicated that checker size was the limiting factor, as, above a certain number of heats, the fuel and varying production costs rose at a markedly increased rate, whereas, refractories cost per ton was the lowest at the 200-heat point. The current campaign length was 150 heats.

Bogeys were then set up for a minimum fuel and production costs and refractories cost. Curves were plotted to show cost above bogey for campaigns increasing by ten heats, from 120 to 200 heats. These are shown in Figure 1. Lines A and B intersect at 160 heats, this showing that the excess refractories cost is equal to the excess fuel and production cost. Curve C shows the sum of all excesses above bogey.

Studying these curves, we see that a minimum ingot cost is reached at 140 heats. Between 140 and 180 heats, the decrease in refractories cost is balanced by the increase in the other costs. Above 180 heats, the curve again rises rapidly. Thus, in our shop, a campaign longer than 180 heats would not be economical. On the other hand, the life could be shortened to 140 heats without increasing ingot cost. This could be done if one were interested solely in maximum production rate for the furnace. A longer campaign is preferred in most shops at the present time because maximum furnace availability is of extreme importance in maintaining peak production for the entire shop. However, our experience has shown that, if the 180-heat life is aimed at, there are some roofs lost. A collapsed roof will boost the ingot cost some 10 or 12 cents per ton for the entire campaign. Therefore, a life of 165 heats is believed to be preferable.

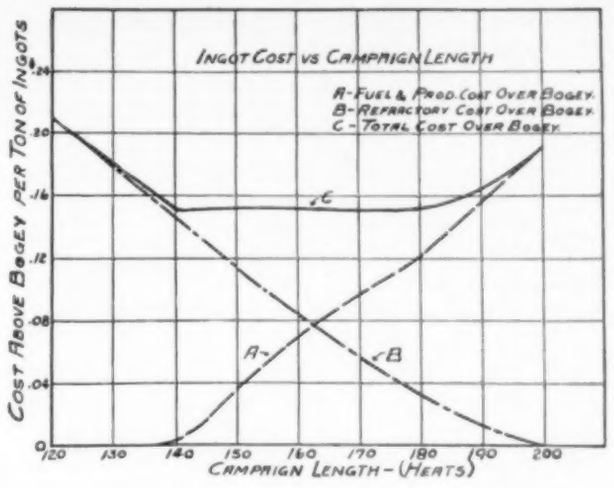


Figure 1 — Cost above bogey for increasing lengths of campaign.

The campaign length indicated was adopted as standard and furnaces were scheduled to go down for rebuild at that time. This gave the added advantage that rebuild work could be planned and executed with less delay.

In our case, it was found that some roofs failed at points to the left of the 170-heat point. These failures were traced to silica bricks containing over 1 per cent Al_2O_3. By keeping Al_2O_3 under 1 per cent, the roof life was raised above the point desired.

ALL-BASIC ROOFS

Should the operator wish to gain the added refractoriness of basic brick, he must gain enough benefit to carry the additional cost, and must also devise ways and means of supporting the brick in a satisfactory manner.

At least four companies are now trying all-basic roofs. Whether or not the results will show a saving per ingot ton is still an open question.

A recent communication from an operator who has had, by far, the most experience with all-basic roofs (five full campaigns) discloses that the all-basic roofs furnace showed a production gain of 6.4 per cent over the average of comparable silica roof furnaces. Allowing for increased cost of roof, front and back wall, and fuel cost and reduction in fixed cost, this increased production was gained at an expense of $0.267 per ingot ton. The figures further show that, to have realized a

roof cost equal to that of the silica roof, the basic roof should have lasted 723 heats.

At the present time, there are at least 30 furnaces operating with basic ends, and some shops are contemplating building all furnaces with basic ends.

Advantages claimed for basic ends are as follows:

1. Decreased refractory cost.
2. Increased production.
3. Ease of slag removal.

Disadvantages:

1. High cost of brick.
2. Requires suspension.

Decreased refractories cost is a result of longer life, smaller total volume of brick used, and fewer replacements.

Increased production is a result of less down time for repairs and rebuild and harder driving of furnaces. In cases where furnaces have restricted uptake area, the use of basic brick has made possible larger areas and thereby some increase in production.

Some fairly accurate data on decrease in refractories cost by use of basic ends have been accumulated. Overall savings in refractories cost of from $0.10 to $0.28 have been reported.

The actual increase in production is less definite but, in general, an increase of 5 per cent is the accepted figure.

Oxygen itself has not been shown to have any deleterious effect on refractories. However, indirectly, its use has, in many cases, shortened refractory life.

In the case of oxygen for combustion of fuel, many early experiments resulted in damaged roofs. However, experience has shown that, with care, this can be largely avoided. As pointed out earlier, if oxygen is used during the melt down, the cold charge is capable of absorbing heat as fast as it is furnished by the flame, and, if the latter is properly directed, no great increase in roof temperature should result. However, plants reporting in the American Iron and Steel Institute questionnaire show as high as 15 per cent reduction in furnace life. In general, it is believed that, with further experience and some changes in furnace lines, this figure will be reduced to under 10 per cent.

Shortened furnace life has also been reported from the use of oxygen for decarburization. Here again, some reports show considerable damage while others report none. The two main causes are splashing of slag and metal and oxides carried by the furnace gases. Operators have found that, in using oxygen below 0.2 carbon, and with care, little splashing results. Oxides in the furnace gases might have some fluxing effect on the acid refractories, and the use of basic brick would lessen this effect.

In our case, we have not experienced shorter furnace life from the use of oxygen for decarburization.

SLAG CONTROL

The last item to be discussed is that of greater production by slag control.

For the open hearth operator, slag control consists mainly of two parts; namely, control of basicity, or base to acid ratio, and control of slag volume. Oxide control is purposely omitted.

Slag basicity desired is that which will eliminate the sulphur and phosphorus to the range desired. Slag volume should be the minimum amount that will do the above job well.

The theory of slag control is very simple. To flux silica requires lime. The more silica or silicon to form silica, the more lime needed. Therefore, for low slag volume, use low silica or silicon charge materials. The result is better production.

To eliminate sulphur or phosphorus, the slag must be basic and in large enough volume to receive and keep the compounds of these elements that the slag-metal equilibrium will allow. Again, for low slag volume, keep the charge as low as possible in sulphur and phosphorus. This is elementary, but the suppliers of raw materials for the open hearth are apt to forget it. Working down sulphur in a high sulphur heat is time consuming and loses production.

On the other hand, using more lime than is required for correct basicity is a good way to lose production. Fetters and Mahaney have shown this nicely in a recent paper, and Figure 2, taken from their work, gives concrete evidence of the increase in production by slag control. In the graph $R = \frac{\text{Tons per hr X 100}}{\text{Heat Size.}}$

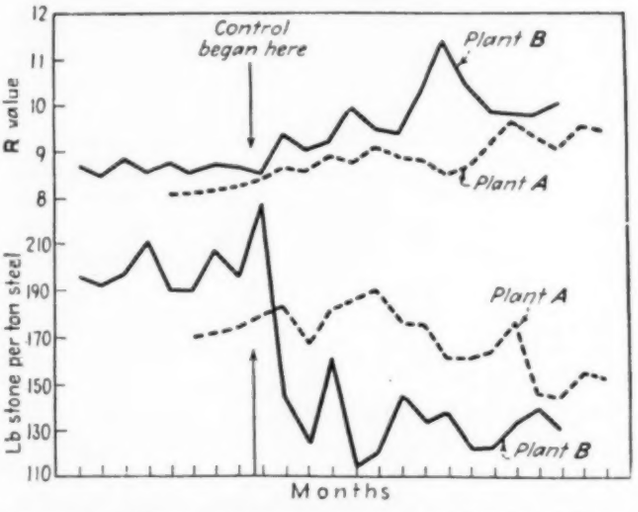


Figure 2 — Effect of slag control on production rate and on pounds of limestone required per ton of metallic charge.

In the case of high hot metal heats, we have a good illustration of slag control by charge materials. The flush off is the key to good slag control. A fast vigorous flush eliminates excess silica early. This is obtained by having the charge ore or sinter low in silica and moisture and well heated before the hot metal addition, and adding hot metal at the right time. Skill at this stage is a great asset in fast steelmaking. Also, the more silica run off in the flush, the less need be fluxed by time later. This should be called slag control.

CONCLUSION

We have discussed separately the possibilities of in-

creasing production by the use of oxygen, better refractories, and slag control. To make the picture complete, an attempt should be made to estimate the gain that could be achieved if all these aids were to be utilized.

First, it must be recognized that some plants will benefit far more than others. In shops that have modern furnaces, with large bath area, bath depth under 30 in., roomy uptakes, large checkers, and modern combustion control, little may be gained with combustion oxygen. Furnaces already equipped with basic ends have less to gain from refractory improvement.

For our purpose, let us examine the possibilities for a shop of medium age, all silica brick, and rather restricted furnace dimensions. From reported data, and using figures on the lower side, the author will hazard the following estimate:

Increase by oxygen for combustion	15 per cent
Increase by oxygen for decarburization	8 per cent
Increase by using better refractories	5 per cent
Increase by charge and slag control	2 per cent
Total	30 per cent

To attain this goal will not be easy. Many changes to auxiliary equipment will be necessary and much skill in applying the new practices will be required. But, knowing the intelligence and drive of the modern steelmaker, we believe that goal can be attained.

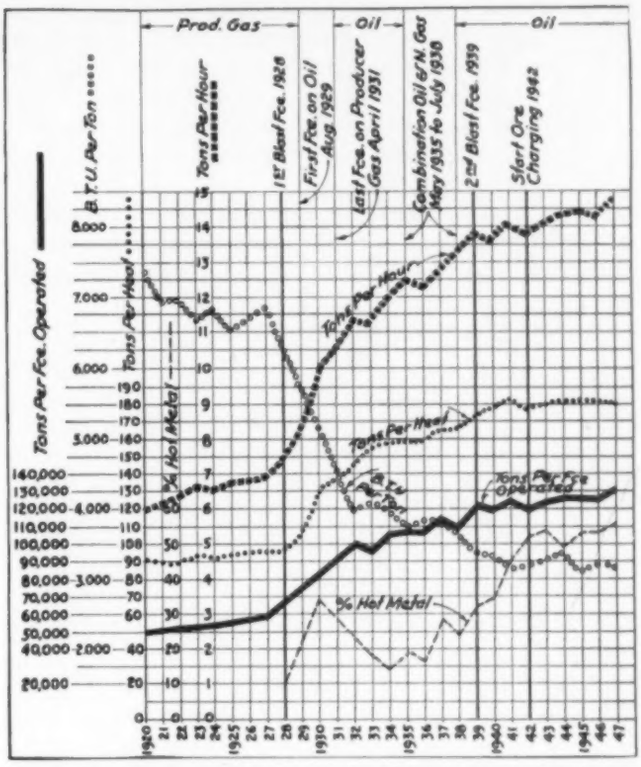


Figure 1 — Tons per furnace operating, tons per heat, per cent of hot metal and Btu per ton melting from 1920 to 1947. (Middletown Division, Armco Steel Corp.)

"MATERIAL HANDLING AND TRANSPORTATION IN OPEN HEARTH OPERATIONS"

by W. W. BERGMANN, Assistant Supt., Open Hearth Dept., Armco Steel Corp., Middletown, Ohio.

▲ STATISTICAL studies made after furnace enlargement show that the production rate is in direct proportion to the speed with which limestone, ore, scrap and pig iron are delivered and charged. The contents of this paper are restricted mainly to the work done in the open hearth department at the Middletown Division of the Armco Steel Corp.

This shop was completed with eight open hearth furnaces in 1917, and operated on cold pig and scrap until 1928, at which time hot metal from our blast furnace at Hamilton, Ohio, was made available. It operated on 35 per cent hot metal and 65 per cent scrap until 1939 when the second blast furnace was installed. This changed the practice to 63 per cent hot metal and 37 per cent scrap. The original furnace capacities, which were 73 and 95 net tons, were enlarged to capacities of 175 and 190, the furnaces being rebuilt on the same centers. The tons per furnace operating, tons per heat, per cent of hot metal and Btu per ton melting from 1920 to 1947 are shown in Figure 1.

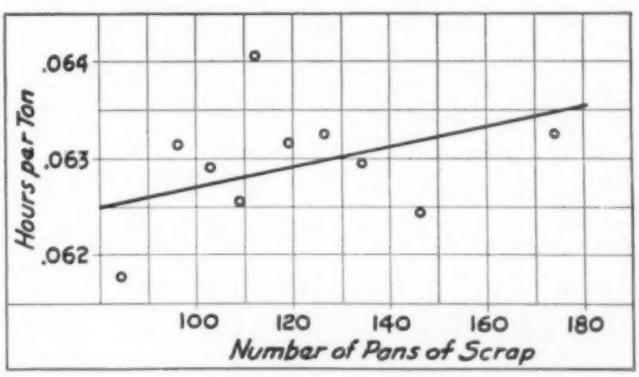
Most of these improvements in operation were made by enlarging the furnaces, better utilization of fuel, increased amounts of hot metal, better scrap handling and preparation, development of track layout and auxiliary equipment. The program of furnace improvement during this period cost $4,280,829 of which $2,592,059 was spent to enlarge the furnaces and increase production, while $1,688,700 was spent for auxiliary equipment.

From its early history, our management has been alert to the fact that steel is not being made until the charge is actually in the furnaces. A definite effort has been made through the years to develop methods to improve the efficiency of handling scrap in the stock yard and, at the same time, increase the weight of scrap per pan delivered to the charging floor. The increase in production by decreased number of pans per heat is shown in Figure 2, as data accumulated from study of 1155 heats.

Back in 1916, a large mechanical bundler was installed to bundle light scrap.

Cars of loose clips are sent directly to the bundler from the receiving yard. The bundles are delivered directly into charging peels from the machine. If clips were handled loose, it would be necessary to load 50

Figure 2 — Increase in production by decreased number of pans of scrap per heat. (Data from study of 1155 heats.)



more pans of scrap per heat at 500 lb per pan. It would require approximately five charging pans to handle the same amount of loose scrap as is compressed into one bundle. This means faster charging and less interference on charging floor. Bushy turnings may be compressed in this mechanical bundler, which reduces the number of charging pans by 75 per cent.

The domestic scrap originating in our plant consists of bloom butts, coil ends and sheet scrap, side and end shearings. The bloom butts are extremely good scrap, but the other types of scrap must be prepared at the source or compressed into bundles.

Domestic scrap, not subject to compressing, is packed and strapped in forms at the source and delivered to the stock yard. These bundles are 72 in. long, 24 in. wide and 18 in. high, average weight 3000 lb. Bundled sheet scrap is loaded into inter-plant cars and sent to the stock yard. The bundles are loaded on piling blocks and spaced about 6 in. apart to avoid breakage when unloading with magnet in stock yard. Bundles are loaded into pans on buggies with a magnet. Sheet scrap bundled at source decreased number of buggies by 66 per cent.

A scrap preparation yard became necessary to relieve the congestion in the open hearth stock yard. Therefore, a modern scrap preparation yard was erected adjacent to the plant to re-shear domestic and foreign scrap. The scrap preparation department consists of two crane runways, each 825 ft in length. Two 7½-ton overhead cranes are on the north runway and three 7½-ton overhead cranes on the south runway. Under these runways there are placed 16 alligator shears and a Harris hydraulic baler.

One hundred and four men are required to operate the scrap preparation yard, two eight-hour turns of six days per week. Approximately 12,000 net tons of scrap are burned, sheared, pressed or sorted for the mill each month. The many different operations involved in handling the different types of scrap make it difficult to gather cost figures for separate items. It requires an average of 1.85 man hours to prepare each ton of scrap. Table I shows a comparison of weight per pan of prepared and unprepared scrap and number of pans required to charge 10 tons of scrap. Every pan eliminated saves 1 minute in furnace charging time.

TABLE I
Comparison of Prepared and Unprepared Scrap Efficiency

Grade of scrap	Weight per pan		Number of pans required to charge 10 tons of scrap	
	Unprepared	Prepared	Unprepared	Prepared
Loose clips	500	....	40	....
Hydraulic bundles	....	1150	..	17.4
Mechanical bundles	....	2500	..	8.0
Loose sheet scrap	1000	....	20	....
Bundled sheet scrap	....	3000	..	6.6
Cut pipe	400	....	50	....
Pipe sheared	....	910	..	21.9
Turnings	800	....	25	....
Turnings admixed in mechanical bundles	....	3000	..	6.6

The handling of limestone by hand or locomotive crane has, in the past, proven to be expensive, slow, and hazardous. Minor accidents were numerous in the hand loading and the job was very undesirable. Damage to railroad cars made the cost of handling by locomotive crane prohibitive.

To speed up handling limestone and eliminate an objectional job, a caterpillar diesel tractor, equipped with a front end, one-cubic-yard bucket was put into service.

A section of track was elevated on an earth fill with a 3 per cent grade. It levels off at 9 ft above the ground for a distance that will hold four cars. Two sets of concrete pits were installed under level track. Limestone is dumped from hopper cars into these pits, picked up by scoop on the front of the loader and carried to buggy track and discharged into pans. The machine transfers the limestone to the storage pile from pits and loads the limestone from the storage pile into pans.

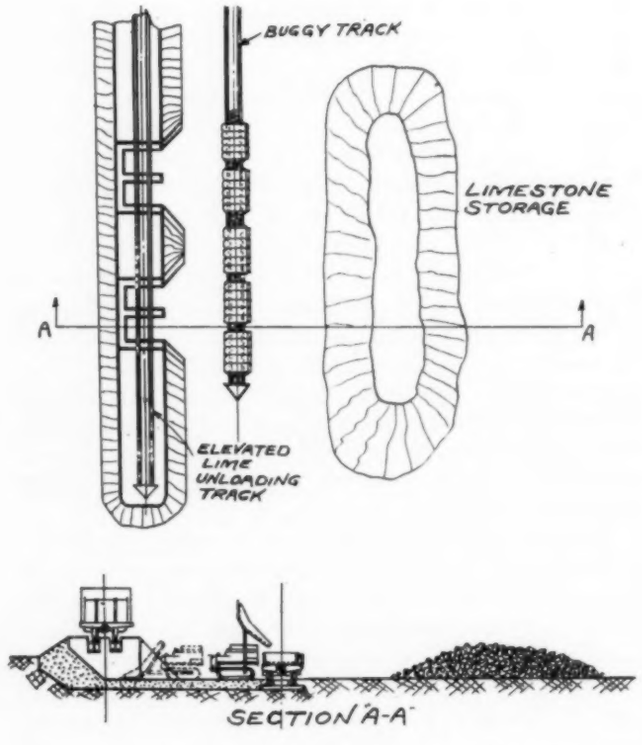
The loader handles 5000 tons of limestone, 170 tons of fluorspar, 1000 tons of dolomite and 2500 tons of ore each month.

This machine is also used to remove slag from basic end open hearth furnaces. It does this job in three hours, the previous method requiring 200 man hours.

Long buried steel scrap iron buttons are a source of critically needed scrap. We are reclaiming about 25 tons of scrap iron a day from an old slag dump. All reclaimed scrap from this dump is sent directly to the open hearth stock yard in dump trucks.

We have installed a button cutting station under the stock yard runway. The burner is set up on a small trolley which operates on a five-foot-high runway. The burner travels in any direction. Cutting speeds average from one to three in. per min, depending on the thickness and the cleanliness of the steel being cut. We cut buttons up to 30 in. thick. The stock yard crane places

Figure 3 — General arrangement of limestone unloading dock.



the buttons on the burner rack. After the button is cut the crane loads the pieces onto a charging peel.

All furnace slag is taken out to the slag dump where it is reclaimed for shipment to the blast furnaces. There are five slag dump cars in this service. Cars are transported to the slag dump with a 100-ton diesel locomotive. A flat car equipped with a large air storage tank and a 200 cfm compressor provides sufficient amount of air to dump five thimbles. The compressor is operated while making the trip to the dump to build up pressure in the storage tank, thus making it possible to dump thimbles as soon as cars are spotted.

We now rehandle every bit of refuse going to our current dump in order to reclaim metallic iron. We reclaim about 1000 net tons of scrap per month.

It requires about 43 men to operate the following equipment at the current and the old slag dump:

1—Lima 3 cu yd crawler shovel.
1—Marion 2¼ cu yd crawler shovel.
1—Lorain 1½ cu yd crawler shovel.
4—½ to 1 cu yd motor cranes with magnets.
7—Bulldozers.
5—7- to 10-ton heavy duty dump trucks.
1—50-ton drag for moving equipment.

The open hearth stock house has one crane runway 900 ft in length, parallel with the open hearth building. In this stock house there are three 15-ton overhead cranes equipped with 65 in. magnets. All loading of charging pans, with the exception of bundled clips at the mechanical bundler, is done in this yard. Three times a day the mill transportation system switches the stock yard by removing all empty cars and spotting full cars on the track adjacent to the scrap piles. A three-day supply of scrap iron is stored inside the stock house.

The empty buggies which have been returned from the charging floor are spotted on the track next to the scrap iron cars, then the scrap iron is loaded into buggies with the overhead cranes. Two stockers on each turn trim all the pans loaded with light weight scrap iron. Whenever possible, small scrap iron is salted in with other scrap iron to increase the weight per pan. The only scrap preparation done in this yard is by one man burning coil ends or pipe to charging pan size and one man operating a button burner.

The transportation equipment in the stock yard consists of the following:

70-ton diesel locomotive.
25-ton dinkey locomotive.
129 stock yard buggies equipped with automatic couplers and roller bearings.

The 70-ton diesel locomotive does all the switching in the stock yard to make up the drags and deliver them to the charging floor. The 25-ton dinkey is used to remove the empty buggies from the floor and distribute these to different locations in the stock yard area. This is an important job due to the necessity for all loaded and empty buggies to go to and from the charging floor over the same tracks. It also relieves the congestion of empty buggies in front of the south furnaces.

The loaded buggies are pulled out of the stock yard by a 70-ton locomotive over a track scale located 400 ft from the stock house. This scale is equipped with an attachment which will automatically weigh buggies traveling over it at a speed of one to three miles per hour. This is a time saver and also decreases maintenance cost on the rolling equipment. After buggies are weighed, they are transported to the furnaces.

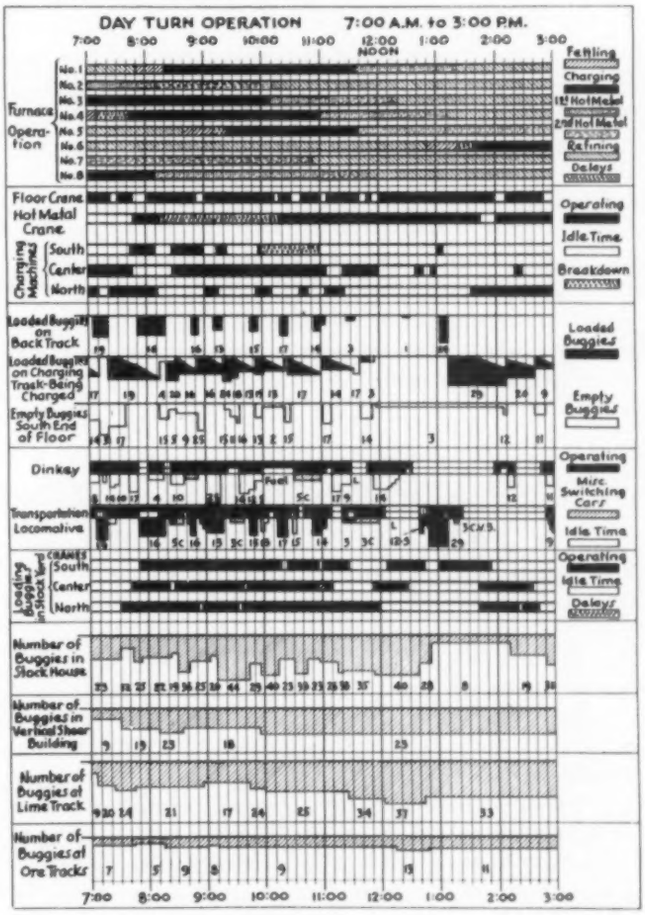
The stock yard turn foreman contacts the melter to get first hand information with reference to the time each furnace will tap. Due to all scrap iron being delivered over one track at the center of the plant, it is important that drags are delivered in correct sequence to eliminate charging delays.

Three 5-ton, low type charging machines are used on the charging floor. To speed up charging we have used two charging machines to charge one furnace. When it is necessary to charge two adjacent furnaces at the same time, drags are split up to relieve the congestion and eliminate a delay on one furnace.

Figure 4 shows sequence in operation of handling material and transportation in the open hearth department over an eight-hour period.

This chart shows the congestion and interference on the charging floor due to the necessity for charging four furnaces at one time. As indicated on the chart, the average total time from the start of charging to the finish of charging in these four furnaces was 177 minutes—low 135 minutes and high 195 minutes. Average of the actual charging time was 110 minutes. Statistical reports on charging show that we make the fastest heat time when all scrap is charged into the furnace in less than two hours. The hot metal crane delay shown on the chart from 1:15 A.M. to 10:15 A.M. resulted in

Figure 4 — Sequence in operation of handling material and transportation in the open hearth department over an eight hour period.



long time of hot metal addition on No. 2, 7 and 8 furnaces.

We receive hot metal from the Hamilton blast furnaces located 10 miles from the Middletown open hearth department. Approximately 48,000 net tons of hot metal are transported each month in eight, 150-net tons hot metal cars. Two hot metal cars, one steam locomotive and one caboose, make up the train. It requires five round trips per day (120 minutes per round trip) to keep the open hearth department supplied with hot metal.

Hot metal is poured into a 100-ton ladle, transported to the furnace with a 150-ton hot metal crane. The 100-ton ladle size is limited by the capacity of the crane runway and crane limitations. The size of the ladle makes it necessary to make two hot metal additions on all ore charged heats.

The open hearth pit operation is primarily a problem of material handling and transportation. This problem increased with every furnace enlargement. The size of heats was increased three times in the past twenty years. To handle these larger heats we changed the shape of ladles from round to elliptical without changing the height. The cinder pot capacity was increased from 260 to 400 cu ft.

All slag and debris at ladlestands are cleaned up with a two line heavy duty clam shell bucket.

When heats were increased to 190 heats in 1941 we had to increase the number of ingots poured on each heat. The larger heats required a longer drag of buggies than our pouring platforms would accommodate. By turning the molds 90 degrees, and putting three molds on the buggies in place of two, we were able to shorten the length of the mold drags by 33 per cent. By shortening the length of the mold drag we were able to pour larger heats at the pouring platforms and strip the heats at the stripper yard without increasing the length of the stripper yard runway.

A one-ton capping crane is used to handle mold caps in capping heats—at the pouring platform—cap weighs 450 lb. The crane travels the complete length of the pouring platform—the trolley travels about eight ft. The trolley boom is hinged on the bridge and is swung out over molds and locked when capping heats. The small cab located on the end of the bridge is covered with two thicknesses of copper screen to protect the operator from the heat.

"FINISHED STEEL PRODUCTION — POSSIBLE INCREASE FROM EXISTING EQUIPMENT"

by R. F. PASSANO, Metallurgical Engineer, Bethlehem Steel Co., Bethlehem, Pa.

▲ AN increase in amount of finished steel products can be accomplished with or without an increase in quantity of steel produced by the steelmaking units. Both of these procedures are discussed below.

Suppose it were physically impossible for the steelmaking units to produce even one additional ton of steel in the ladles at the steelmaking operations. The quantity of steel products available to the trade could still be increased by a substantial amount if we obtained more product and less home scrap per cycle through the operations.

Heating is an essential step in every hot rolling operation. Every time steel is heated, a certain amount of it is lost as scale. If one heating operation can be omitted, the loss that goes with it is converted to potential product. A poor heating job accentuates surface troubles. This necessitates more conditioning, which means more loss of material, and that in turn means increased variability in the product of the operation.

Reclamation is a provocative word. It implies an operation on its own account: perhaps a second set of shears in line with the first. Generally, reclamation is unsatisfactory because the material to be recovered must match the orders being rolled in grade, section, quantity, delivery and what not. Reclamation can be efficiently handled only as an expansion, but integral part, of the specification of the rolling order.

So, let us examine this business with a thought toward decreasing the amount of prime steel that goes into home scrap and thus accomplish reclamation without an extra operation.

Three examples will suffice:—

1. One of our open hearth shops contains furnaces that were all built to the same design. The shop has been operating at record rate for several years. In the year 1948, the average weight of heats from these furnace was 213.2 tons, but some turned out considerably less and others considerably more than that amount.

2. Recently a group of four ingot molds were made consecutively off the same pattern at our ingot mold foundry. These were placed in service on new stools mounted on one buggy and they were filled to the same height with steel. The ingots therefrom were reduced on the blooming mill consecutively to the same cross section. From the blooms as rolled, a set length was cut for conversion to product. The length of bloom left over from each ingot was measured after cutting the set length. The same measurements were repeated on the next three heats out of these molds with the results shown in Table I.

TABLE I

Length of Discard from Blooms in Inches

Mold number	Heat identification			
	2	3	4	5
138	99	92	81 min.	98
139	95	97	87	98
140	97	97	101	104 max.
141	87	94	86	98

3. A group of identical billets was rolled to round bars not so long ago on one of our mills. These bars were cooled on the hot bed. The front ends were aligned; the back ends took the position which indicated appreciable differences in length.

Here, in brief, are three essential steel plant operations. Each starts with what is alleged to be a constant charge of raw material. This raw material is put through

fixed operations. The product that emerges is inherently variable between successive identical charges.

LOSS FROM LADLE TO INGOTS

In the interest of not wasting steel that is in the ladle, we want enough molds to take all the steel that is there. To avoid congestion, the string of molds should be no longer than necessary.

In general, large sections are made from large ingots. Roughing mills take about the same reduction on ingots of different cross section. Other things being equal, a roughing mill can produce more tons of product in unit time from big ingots than from smaller ones.

The larger the ingot mold in which the steelmaking units pour, the greater is the loss in partially filled ingots at the end of the pouring at the steelmaking units.

Yields may vary as follows:

Weight of ingot, lb	Per cent yield
15,000	98.3
25,000	97.0
35,000	95.8
43,000	95.0

Steel production that is lost in this way will not be regained.

However, if one can apply steel that must be made for large sections in small sections as well, there is no reason why large ingots should not be made for the first part of the heat and small ingots for the latter part. One can secure as high a yield in strings composed of big and little molds as one can secure in strings composed of little molds exclusively.

For the heats that average 213.2 tons apiece with the smallest at approximately 190 tons, one should figure on making a maximum of 190 tons in large molds with the balance in the small molds (assuming there are no considerations other than yield). The smaller the tail-end molds can be, the better the yield.

LOSS FROM LADLE TO SLABS FOR HOT STRIP MILL

If the the prime length of the slab as rolled on the roughing mill is greater than the length of the slab heating furnace, it must be cut down to fit the slab heating furnace. This results, of course, in waste of perfectly good steel that the steel producing units worked hard to get.

In considering this problem it is convenient (if not always exact) to assume that the slabs, as rolled from a given ingot to a given cross section, must be cropped a definite number of inches to square the one end and rid the other end of pipe.

We can regulate the distribution of length of slag as rolled by regulating the pouring height of the ingot (i.e., its nominal weight). The heavier the ingot, the fewer ingots we can expect to obtain over a long series of heats provided no small, tail-end ingots are used.

We have assumed that the slabs as rolled are cropped the equivalent of 4028 lb to produce an end condition which makes the slabs suitable for rolling. Any that are heavier than 25,000 lb are trimmed to that weight, in order that they will fit the slab heating furnace.

Figure 1 shows the average loss in pounds from individual slabs as rolled from a given nominal weight of ingot. Figure 2 shows the total tonnage of hot rolled sheets that might be made, beginning with 213,200 tons of steel in ladles at the open hearth. It takes into account the restrictions laid down and assumes that the hot strip mill has time to roll all the pieces.

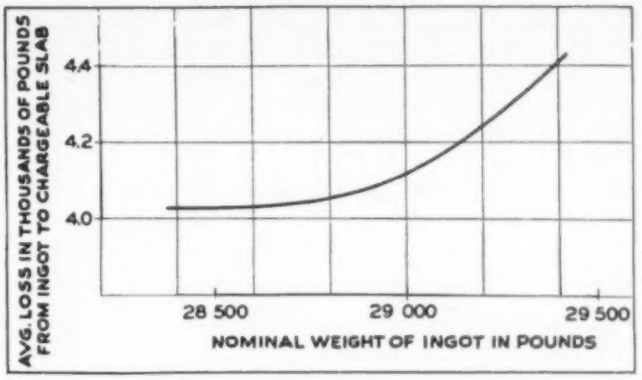
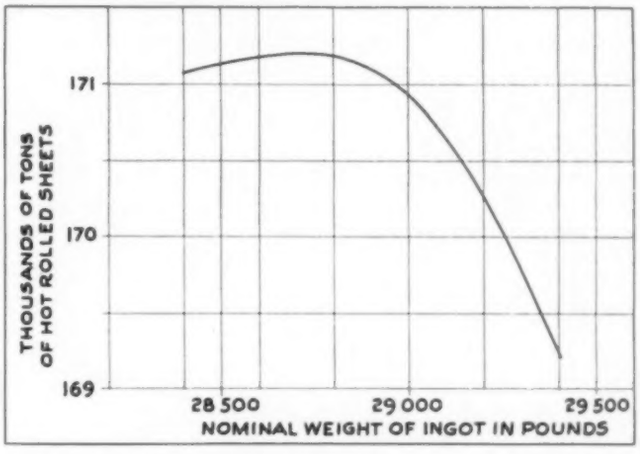


Figure 1 — The average loss in pounds from individual slabs as rolled from a given nominal weight of ingot.

Figure 2 — Total tonnage of hot rolled sheets that might be made, beginning with 213,200 tons of steel in ladles at the open hearth.



The result is an optimum weight of ingot from the viewpoint of conservation of steel in the ladle.

It appears that a sacrifice of steel at the roughing mills to accomplish gain at subsequent operations is a policy that is hard to substantiate.

LOSS FROM BILLETS TO BARS

Let us say that the bars are supposed to shear into 40-ft lengths and the customer will not accept bars that are short of that length. Under these conditions, any bar that is less than 40 ft long is a complete loss and any bar over 40 ft can yield only 40 ft of product and the excess is loss.

Suppose we were able to collect on the hot bed a large number of bars rolled at the same setting on the mill from one single variety of billet, and that we were able to arrange these bars as rolled in order of length from the shortest to the longest with one end against a stop. We should find that the back end of these bars would describe an "S" shaped curve. Figure 3 shows such an arrangement.

We can place this "S" shaped arrangement of length

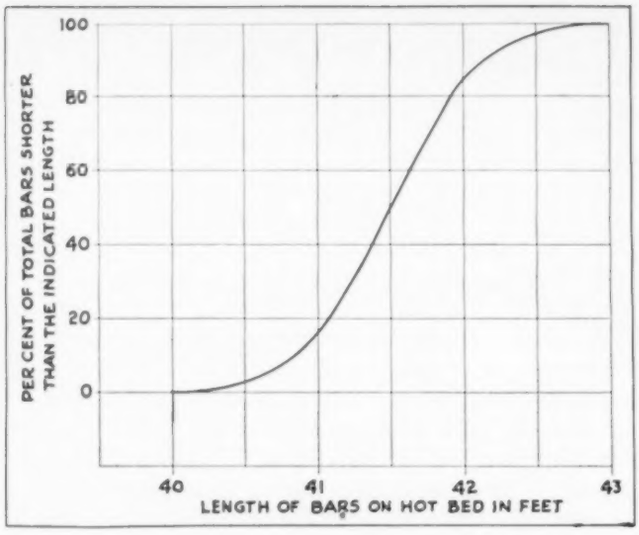


Figure 3 — "S" shaped curve formed by back ends of bars.

as rolled wherever we want it with respect to the ordered length of 40 ft by changing the weight of billet charged to the mill.

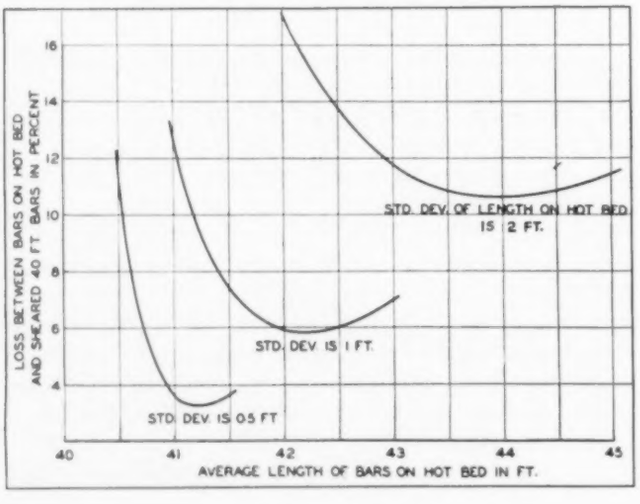
If the shortest bar as rolled were 40 ft long, we should obtain, under the circumstances of Figure 3, one hundred 40-ft lengths from one hundred bars as rolled and lose 150 ft of bar off the back ends, or, an average of 1.5 ft per finished piece, which is a yield of 96.5 per cent from rolled bar to product.

Let us shift the position of the "S" shaped curve with respect to the ordered length by varying the weight of billet charged and repeat the observations of the paragraph above for each weight of billet.

It may or may not be a surprise, but it is certainly true, that there is a relation which the bars as rolled must bear to the length sheared if the loss is to be a minimum as shown in Figure 4. This best length happens to be one that produces about one per cent of the bars short of the ordered length after shearing.

The indication of these deliberations is, of course, that the yield can be improved by controlling the length on the hot bed.

Figure 4 — Relation which bars as rolled must bear to the length sheared to hold loss to a minimum.



POTENTIAL GAIN BY DECREASING LOSSES

In the year 1948 the United States produced 65,973,-138 tons of steel products from about 88,250,000 tons of ingots. The difference of nearly 22,280,000 tons was partially lost; some was cinder and scale, but the majority was home scrap which recirculated in the plant. An increase of yield off the roughing mills, and off the finishing mills could convert some of this home scrap to product without change in production of steel ingots.

When the steelmaking units produce an increased quantity of steel, the mills must handle it or no increase in the amount of finished product will be observed.

Let us assume that all the operating hours on the roughing mills are scheduled, and there are still ingots to be rolled. If it were arranged to roll two ingots at a time, (which the slabbing mill is doing), the time lost from gainful reduction of the ingot (as the rolls are moved from one rolling position to the next) would be spread over two ingots instead of one, and the production thus increased 20 per cent or thereabouts.

There are those who have found round ingots quite satisfactory from the point of view of quality. Such in-

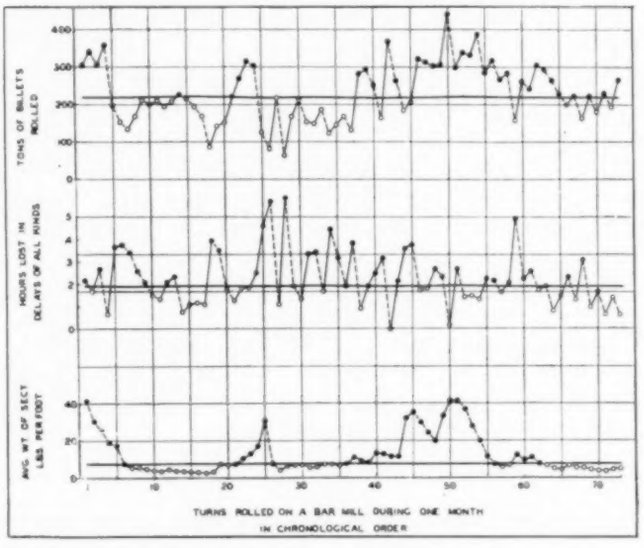

TONS OF BILLETS ROLLED
HOURS LOST IN DELAYS OF ALL KINDS
AVG WT OF SECT LBS PER FOOT
TURNS ROLLED ON A BAR MILL DURING ONE MONTH IN CHRONOLOGICAL ORDER

Figure 5 — Turns rolled on a bar mill during one month in chronological order.

gots can be started into the roughing mill with no particular trouble and flattened on two sides. When the flattened ingot is turned 90 degrees to make the second pair of flat sides, there is a moment of suspense before the partially broken-down ingot enters the mill for this pass. It has been found that square or rectangular ingots, with suitable corners and corrugations, will produce the same high quality of steel. These eliminate the hesitancy when starting the second pair of flat sides and so enable the roughing mill to roll more ingots per hour.

Such ideas as these enable the roughing mills to keep their rate of rolling in step with the rate of production from the steelmaking units. If this can be done, one may question the ability of the finishing mills to take the increased amount of roughing mill product.

A typical finishing mill performance by turns is shown in Figure 5. Our interest lies in the tonnage of finished material that the mill produces. It varied con-

siderably in the period shown. From one turn to the next, the change in production is largely a matter of delays, but, over an extended series of turns, it is evident that the production increases as the weight per foot of product increases. If the same range of products must be made under the condition of increased steel production, we cannot change the weight per foot of product in any violent fashion. We must gain rolling time on the mill by decreasing delays.

Some of the delays are due to insufficient preventive maintenance (seemingly accidental things), while others are connected with the problem of furnishing a particular customer with a unique bit of product, regardless of the general demand.

This particular mill is capable of producing one-half ton per minute when in operation. There is room across the face of the rolls that go into this mill for just so many grooves each of which makes one size of round, for example.

A change from the first groove to the second requires the mill to shut down for the purpose. This repeats when changing from the second to third groove, etc. Finally, when the last groove has finished what it was scheduled to do, the roll set must be changed.

Suppose there are five grooves in the rolls out of each of which 150 net tons can be rolled. Beginning with the rolls in place the history of the set could be as shown in Table II.

TABLE II

Mill Time and Tonnage for a Set of Rolls

Roll first size	300 minutes
Change to second groove	20
Roll second size	300
Change to third groove	20
Roll third size	300
Change to fourth groove	20
Roll fourth size	300
Change to fifth groove	20
Roll fifth size	300
Change roll set	60
Total	1640 minutes

to produce 750 net tons, or 27.5 net tons per hour.

If the tonnage per size is less than the maximum of which the groove is capable, the production per hour falls off as shown in Table III.

TABLE III

Effect of Tons per Size on Tons Produced from Bar Mill

Net tons per size	Min set of rolls is in mill	Production from set, net tons	Net ton per hour
150	1640	750	27.5
100	1140	500	26.3
50	640	250	23.4
20	340	100	17.6
10	240	50	12.5
5	190	25	7.9

Mills are seldom scheduled with constant tonnage per groove at any one of these levels, but combinations involving small tonnages of some size will lower the average tons per size for the set of rolls. The idealized production of 27.5 net tons per hour, if decreased so little as one ton per hour, will become an appreciable loss of finishing capacity when one takes into account that such mills might operate as much as 8620 hours per year, and that there are many such mills in the country.

BASIC REQUIREMENT OF INCREASED STEEL PRODUCTION

When steel is finished and shipped in an amount that exceeds the present production, the basic requirement is to supply the steelmaking units with charging material to maintain the finishing rate. It makes little difference whether the increased production is obtained by charging the furnace faster, by faster melting and refining, or, by decreasing the loss to scrap between ladle and finished product. Ferrous material for the steelmaking units is derived from home scrap, blast furnaces, purchased scrap and ore. An increase in the quantity of steel finished can only mean an increase in ferrous material.

We said that the number of ingot molds in the shop should be limited on account of congestion. There is another reason. The more ingot molds there are beyond the minimum needed for the steelmaking operation, the less molten pig iron there is available for charging into the steelmaking furnaces. Molten pig iron is the best charging material for steelmaking furnaces.

A hypothetical plant may be in position to make its entire production out of 25 x 30 x 84 in. ingots. Its furnaces top some expected number of heats in unit time. The facilities, which move the ingot molds after they are filled, through the stripping, cleaning and remounting operations, take a certain amount of time to get the ingot molds back in position at the steelmaking units.

The number of ingot molds mounted on buggies and in circulation must be such that the steelmaking units are not delayed because of a dearth of molds. Whatever the normal time interval for the molds to be out of the open hearth, the expected number of heats is subject to variations by "bunching."

If the hypothetical plant under discussion figured all heats as requiring the maximum number of molds, the interval that the molds were away from the open hearth at its worst, and the "bunching" as severe as ever could be imagined, that plant would have too many molds on buggies.

Table IV is an estimate of the number of molds that compromises the desire of the open hearth to have as much iron as it can get for charging and have, at the same time, a sufficient number of molds to take care of its production of steel.

TABLE IV

Minimum Number of Molds Needed in Service

No. of heats expected in time interval when molds are not available	No. of molds expected to be filled in time interval	No. of molds needed on buggies to avoid delay at steelmaking units	Tons of steel that can be poured in these molds
40	1120	1352	10,140
20	560	724	5,430
10	280	396	2,970
5	140	222	1,665

SUMMARY

The steel industry can produce more finished product without an appreciable expansion of existing plants. There is so much difference between the quantity of ingots made and the quantity of steel products shipped that it is profitable to ask whether on the next cycle some home scrap cannot be brought out as product. This paper recounts practices that decrease the loss between ladle and finished hot rolled products.

Mill time can be gained by preventive maintenance, "double heading," altering ingot mold shape and consolidation of rolling schedules.

An increase in finished products shipped requires that there be additional ferrous material to keep the steelmaking furnaces charged. A "shot" of such material well may be obtained from the reservoir in excess ingot molds.

"STUDIES RELATING TO THE CONTROL OF SULPHUR IN THE PRODUCTION OF PIG IRON"

by TRUMAN H. KENNEDY, General Supt., and ARTHUR W. THORNTON, Division Supt., National Tube Co., McKeesport, Pa.

▲ THE sulphur holding power of blast furnace slag may be more fully utilized in the elimination of sulphur from the iron in the blast furnace by appropriate alteration in slag compositions. The present work had as its aim the determination of the most effective range of slag compositions for sulphur removal within the limits of the materials available.

For practical purposes, all sulphur entering in the furnace burden can be considered as finding its way into either the slag or the iron. To measure the effectiveness of any slag to carry sulphur, it has been found significant to consider the distribution of sulphur between slag and iron. This method has the advantage of being independent of the amount of sulphur charged and the slag volume, if it is assumed the simple distribution law functions over the usual range of variation in commercial practice. This means that if the total sulphur charged is increased the percentage increase in both slag and metal will be proportionate and the ratio will remain constant.

In order to study the factors which tend to give the highest sulphur ratios, a series of tests was made on a blast furnace equipped with a carbon bottom and a serrated large bell, with a hearth diameter of 22 ft, 5 in. The furnace was producing Bessemer hot metal with aim specifications of 1.40 per cent silicon, 0.025 per cent sulphur, 0.080 per cent phosphorus, and 0.55 per cent manganese. The furnace was operated on 100 per cent Mesabi ore and beehive coke made from 100 per cent high volatile coal. The ferrous charge was unchanged throughout the series of tests.

Slag compositions were altered during the experiment by varying the amount of dolomite and limestone in the flux charge.

In the first phase of the test, the flux consisted of 100 per cent limestone; in the second, 35 per cent dolomite and 65 per cent limestone; in the third, 70 per cent dolomite and 30 per cent limestone; and in the final test, the flux burden was 100 per cent dolomite. The average percentages of lime and magnesia in dolomite were 30.36 and 21.11 respectively, and the limestone analyzed 52.55 per cent lime and 0.64 per cent magnesia.

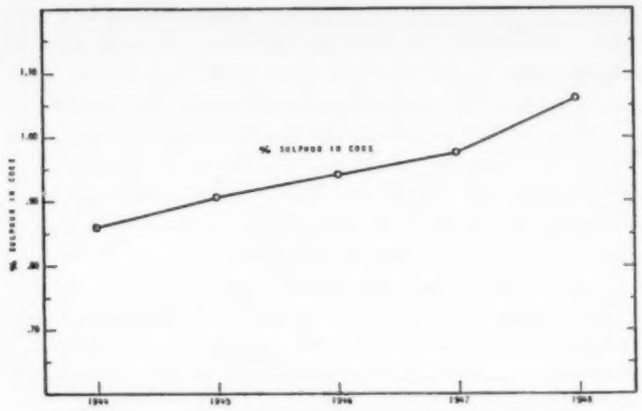
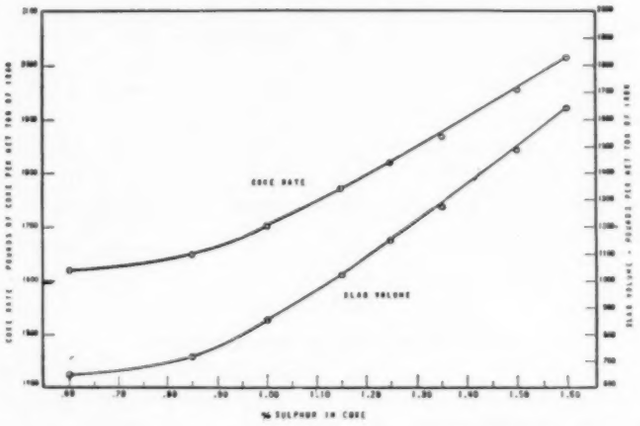


Figure 1 — Gradual increase in the sulphur content of coke used at National Works.

Figure 2 — Effect of sulphur in coke on coke rate and slag volume.



If uniformly low sulphur iron is expected, any increase in sulphur entering the blast furnace requires either a corresponding increase in slag volume or basicity. Increased basicity is to be preferred to increased slag volume, providing the proper slag fluidity can be maintained.

It is evident that lime is a more potent desulphurizer than magnesia. The presence of magnesia provides a means of operating on more basic slag than is practicable with straight lime slags.

Increased magnesia, beyond the minimum required for fluidizing the slag, results in a reduction in sulphur absorbing power, the effect of which is to require the addition of more flux, an increase in slag volume, a consequent increase in coke rate, and loss of iron production. In this test, the best results were obtained with 35 per cent dolomite—65 per cent limestone.

The sulphur ratio appears to be a useful index of the effectiveness of desulphurization. It may be of special value at plants where large fluctuations in sulphur in the coke are frequent, since it indicates at once whether a change in iron sulphur is due to a change in the amount of sulphur charged or to an inefficient desulphurizing medium.

Other factors might influence desulphurization of

pig iron in the blast furnace: the use of oxygen or steam in the blast, injection of flux in the tuyeres, and the use of slag thinners, are among the items which could be studied in this connection.

"SULPHUR CONTROL AND MANGANESE CONSERVATION IN OPEN HEARTH FURNACES"

by D. E. BABCOCK, Metallurgical Engineer, Republic Steel Corp., Youngstown, Ohio

▲ THE first part of this paper reviews in detail the effects of sulphur entering the open hearth furnace in the fuel, the flux, the iron and the scrap, and considers the methods used to control sulphur.

TABLE I

Estimated Manganese Balance Sheet for the Steel Industry of the United States on a Per Net Ton Ingots Basis

	Per cent	Lb Mn/ NTI	Ingot recovery lb/ NTI	Waste in slags lb/ NTI
Manganese residual OH fce.	0.167	3.34	3.34	....
Mn recovery effi in OH bath	13.47	....	....	....
Average slag volume	17.70	354.00	....	....
Manganese in OH slags	6.06	21.46	....	....
Total Mn in OH fce charge	....	24.80	....	....
Manganese in pig iron	1.59	17.19	....	....
Manganese in scrap	0.63	6.81	....	....
Manganese in other additions, etc.	....	0.80	....	....
Total entering	....	24.80	....	....
Lb Manganese as additions	....	14.70	....	....
Lb Mn recovered as alloy	....	9.30	9.30	....
Lb Mn to ladle slags	36.75	5.40	....	....
Lb manganese at ferro and spiegel fces as ores	....	19.05	....	....
Lb manganese recovered	....	14.70	....	....
Lb manganese lost at alloy furnaces	....	4.35	....	4.35
Lb manganese at pig iron blast fce ores	....	23.20	....	....
Lb manganese recovered at pig fce	....	17.19	....	....
Lb manganese wasted at pig iron blast fce	....	6.01	....	6.01
Lb manganese in OH fce tap, flush, and ladle slags (Total)	....	26.86	....	....
Lb manganese recovered sent to blast fce (25 per cent of OH slags produced)	....	6.72	....	....
Lb manganese wasted at OH fces as slag	....	20.14	....	20.14
Total recovered in ingots	29.29	....	12.64	....
Total wasted blast fce and OH fces	70.71	....	....	30.50
Newly mined manganese required at pig blast fce ores	16.48	....	....	....
Newly mined manganese required at ferro and spiegel fce and other sources	19.85	....	....	....
Total new manganese required at all fces	36.33	....	....	....
Mn recovered from scrap	6.81	....	....	....
Total Mn entering/NTI, all sources	43.14	....	....	....

The second part of the paper discusses the related problem of manganese consumption, and also covers steps for the conservation of manganese.

Table I is an estimated manganese balance sheet for the steel industry of these United States. In it we note that our industry is about 30 per cent or less efficient in present use of manganese. We are utilizing possibly 25 per cent or less of our open hearth slags at the blast furnaces.

For each ton of ingots produced, we are at present consuming 36.3 lb of manganese in the form of ores with an additional 6.8 lb coming from our scrap reserves, making a total of 43.1 lb of manganese introduced into the steel making operation per ton of ingots.

To accomplish the maximum in the conservation of manganese and also the control of sulphur in event of restricted manganese supplies, the steel industry should:

1. Drop all specifications for manganese to the minimum which is required by the quality of the product and its performance. This is by far the simplest and most direct method of minimizing the requirements for manganese.
2. Transfer manganiferous ores now used on basic furnaces to ferroalloy furnaces for more efficient ultimate recovery of manganese in ingots. One lb of manganese at a ferroalloy furnace equals 4.9 lb used at the basic blast furnace. The saving is 3.9 lb of manganese in ores for each 4.9 lb transferred. This may mean using iron of less than 1 per cent manganese, unless open hearth slags not otherwise used are employed to raise the pig iron manganese at the basic blast furnaces.
3. Recover the manganese from the open hearth slags by using them in the basic blast furnace. Phosphorus contents may limit this practice to 60 per cent or less of the slags produced at the open hearth furnace, depending on the per cent of hot metal used in the open hearth and the steel phosphorus limitations, which may require adjustment.
4. Use bessemer vessel and ladle slags in blast furnaces for a lower phosphorus manganese supply.
5. Use open hearth flush and tap and bessemer vessel and ladle slags not otherwise consumed to make lower grade ferromanganese alloys for use in foundry industry. These should not be mixed with high grade ores.
6. Improve the efficiency attained in making alloy additions to ladles by special heat tapping practices.
7. Use only desulphurized or low sulphur fuels to get the maximum results to be attained.
8. Eliminate the wasteful use of furnace reboils with spiegel manganese, etc., where oxygen can be substituted.
9. Control sulphur with the use of sufficient lime charge and a higher flame temperature and better combustion control so that manganese oxide is not required either as a desulphurizer or as a flux for the lime. It may necessitate the redesign of many furnaces to permit faster operations or to avoid changing materially the total heat time or the tonnage production rate under the ordinary condi-

tions under which we can expect to operate. This can be done.

10. The use of higher temperatures, larger amounts of clean, dirt-free scrap, and small slag volumes in some instances should permit the recovery of manganese at such high residual values as to permit the tapping of heats with very little if any appreciable addition of manganese.

FACTORS AFFECTING SULPHUR CONTROL AND MANGANESE CONSERVATION

In detail the factors which can be used to aid in sulphur control and manganese conservation are as follows:

Methods for improving manganese recovery and desulphurization in blast furnace operations: This involves the use of

1. More basic slags where blast furnace production will not be hurt.
2. Lower silicon in the iron is possible without production loss.
3. Beneficiated burdens by sizing burdens and sintering.
4. Use of higher hot blast temperature.
5. Lower total slag volumes.

Methods of improving manganese recovery and desulphurization at the open hearth furnaces requires employment of:

1. Lower slag volumes.
2. Limier slags.
3. Higher temperatures on sharper, faster working furnaces.
4. Fewer ore additions.
5. Lower silicon iron.
6. Clean scrap by the removal of slag materials.
7. Lower hot metal charges with less ore and more scrap heats in some cases.
8. Adequate lime charge at start of heat avoiding other lime additions.
9. No furnace manganese additions.
10. No manganese reboils.
11. Utilization of higher temperature; lower FeO slags when possible.
12. The practice of bringing the heats out of the furnace on rising temperatures to pick up added manganese.

Improving the situation of the ladle with regard to manganese recovery requires that we:

1. Tap without furnace slags.
2. Tap and control slag running onto the ladles, using the German method or other suitable approach.
3. Avoid the use of ferromanganese fines from which little or no manganese recovery is accomplished.
4. Use properly sized lumps.
5. If large additions must be made, preheat them when required.

Increasing the recovery of manganese from waste materials:

1. Use of open hearth flush slags.
2. Use of open hearth tap slags.
3. Use of bessemer vessel and ladle slags.
4. Use of duplex bessemer slags.
5. Recovery of slags from some ferromanganese operations.

"EFFECT OF SULPHUR ON QUALITY AND END USES OF STEEL PRODUCTS"

by M. TENEBAUM, Research Metallurgist, Inland Steel Co., Chicago, Ill.

▲ THIS paper presents a review showing that the specific effects of sulphur on individual properties of steel are reasonably well established. It is sometimes difficult, however, to interpret these effects in terms of product quality, as the quality of any product often involves more than a single property. Whether the effect of sulphur on any grade is critical depends not only on the specific properties being considered, but also on the balance of the steel analysis and the actual practices used in the manufacture, reheating, and rolling of the product.

An attempt has been made in this paper to survey various steel products with respect to sulphur limits needed to meet quality requirements and to indicate the manner in which the influence of sulphur is felt. In

TABLE I

Sulphur Requirements for Various End Uses of Steel

Grade	Sulphur limits		Average maximum sulphur specified to steel-making furnaces, per cent
	Average maximum allowable sulphur, per cent	Property determining sulphur limit	
Commercial quality rim steel	0.042	Rolling surface	0.040
Drawing quality rim steel	0.031	Deep drawing	0.031
Drawing quality killed steel	0.032	Deep drawing	0.032
Welding rod quality	0.032	Welding characteristics	0.027
Structural quality shapes	0.046	Rolling surface	0.043
Structural quality plates	0.045	Rolling surface	0.042
Hot rolled forging quality bars (0.10-0.20 per cent C)	0.037	Rolling surface	0.037
Hot rolled forging quality bars (0.30-0.50 per cent C)	0.043	Rolling surface	0.039
Hot rolled billets seamless	0.035	Rolling surface	0.035
Low alloy high tensile	0.040	Rolling surface	0.030
Rails	0.060	Rolling surface	0.057
Music, bead and rope wire	0.035	Tensile strength	0.035
Commercial alloy	0.040	Rolling surface	0.040
Special purpose alloy a. (for cold heading, 5150 or 9260)	0.033	Rolling surface	0.033
b. (inert arc welded aircraft steel)	0.008	Welding characteristics	0.008
Hot rolled alloy bars (4340)	0.015-0.025	Cleanliness (magnaflux) and rolling surface	0.015-0.025

the evaluation of product quality, consideration was given to both rolling surface requirements and to the specific properties demanded for each end use.

The data on which this paper is based were submitted by 26 steel plants. The average maximum sulphur requirement for each grade and product considered is given in Table I, together with the property most generally conceded to be responsible for this sulphur limit and the average maximum sulphur specified to steelmaking furnaces. It appears from Table I that the maximum sulphur specified to the steelmaking furnaces is determined by its effect on specific properties demanded in the end use in only six of the 16 products considered, two of which were special alloy steels. With the exception of drawing quality cold rolled sheets, welding quality rod and a single special high tensile grade, the maximum sulphurs on the plain carbon grades required to meet surface and rolling requirements within the plant itself are lower than the values needed for the various end uses.

From the data given, it appears that small variations in sulphur content can and probably do exert a significant effect on product quality. The small variations in specified values often can hardly be justified on the basis of the apparently limited information available regarding the effect of sulphur on quality. The confused situation in which the effect of small sulphur variations does not seem satisfactorily defined is particularly pronounced in the case of the commercially important steels for deep drawing applications.

"PALM OIL SUBSTITUTES FOR HOT DIP TINNING"

by W. R. JOHNSON, Research Metallurgist; L. C. KINNEY, Supervisor of Chemical Engineering, and JOHN M. PARKS, Supervisor of Nonferrous Metallurgy, Armour Research Foundation, Chicago, Ill.

▲ APPROXIMATELY 7500 tons of palm oil are consumed annually in making hot dip tin plate in the United States. Over a period of years the price has fluctuated considerably; for example, rising from 8 cents a pound before World War II to as high as 40 cents. In addition, all this oil is now imported from North America and the East Indies over long shipping routes; the United States is in a strategically unfavorable position should an emergency arise which might imperil shipping lanes.

In making hot dipped tin plate, sheets of pickled steel are passed by means of rolls through a flux into a bath of molten tin and up through an 18 in. layer of hot (450 F) palm oil floating on the tin. Three sets of rolls, operating in the oil, smooth and thin the tin coating. See Figure 1.

In order that an oil may operate properly in a tin pot, it should possess at least the following characteristics:

1. It should make smooth, bright, good quality tin plate.
2. It should drain rapidly and freely from the sheet.
3. It should be of low volatility.
4. It should have high flash and fire points.
5. It should neither oxidize nor polymerize readily.
6. It should be cleaned from the sheet readily.
7. It should be of low viscosity at 100 to 200 F so that it may be pumped or poured readily.

If a thin layer of oil is allowed to remain on the sheet, this oil affects the end use of the sheet. Consequently, the oil should possess the following features:

1. It should be non-toxic, odor-free, and preferably edible.
2. It should not become rancid during storage.
3. It should not interfere with lithographing or lacquering procedures.
4. It should not interfere with soldering.
5. It should retard atmospheric corrosion.
6. It should assist handling in fabrication.

Finally, the oil should meet the following important economic requirements:

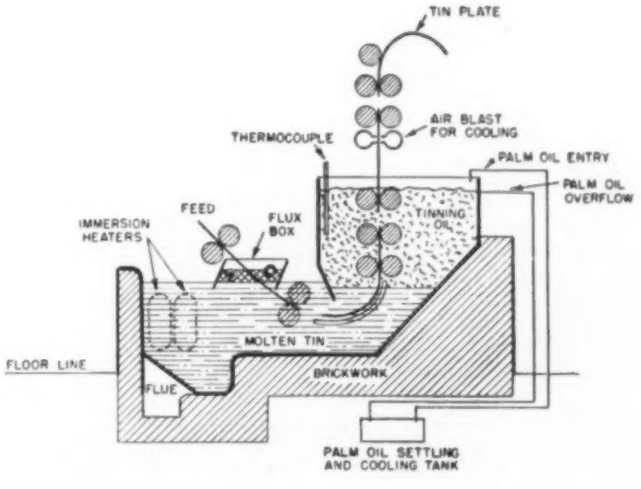
1. It should be readily available, preferably from domestic sources.
2. It should be inexpensive.

Palm oil has been and is a commercially satisfactory tinning oil; it has, however, several deficiencies. Its flash and fire points are low enough to create a fire hazard; it is quite volatile at tin pot temperatures, and tends to increase in viscosity with time at tin pot operating temperatures. A primary disadvantage is its foreign source, and the strategic and financial problems which thereby arise.

It was felt that an understanding of the basic function of tinning oil would be essential to a study of the problem. On the following points the operators were in fairly close agreement.

1. The desirable viscosity for operating palm oil should be about 90 to 100 seconds at 210 F (Saybolt).
2. New or fresh palm oil is not suitable for a tinning oil. It must be heated at pot temperature first or mixed with old palm oil.
3. Tinning oil dragout increases with higher operating speeds, lower coating weights, and rougher sheet surfaces.

Figure 1 — Schematic drawing of a tin pot. The pickled sheet enters the molten tin through a liquid flux bath. It emerges through a bath of hot oil in which three sets of rolls operate to reduce and smooth out the tin coating.



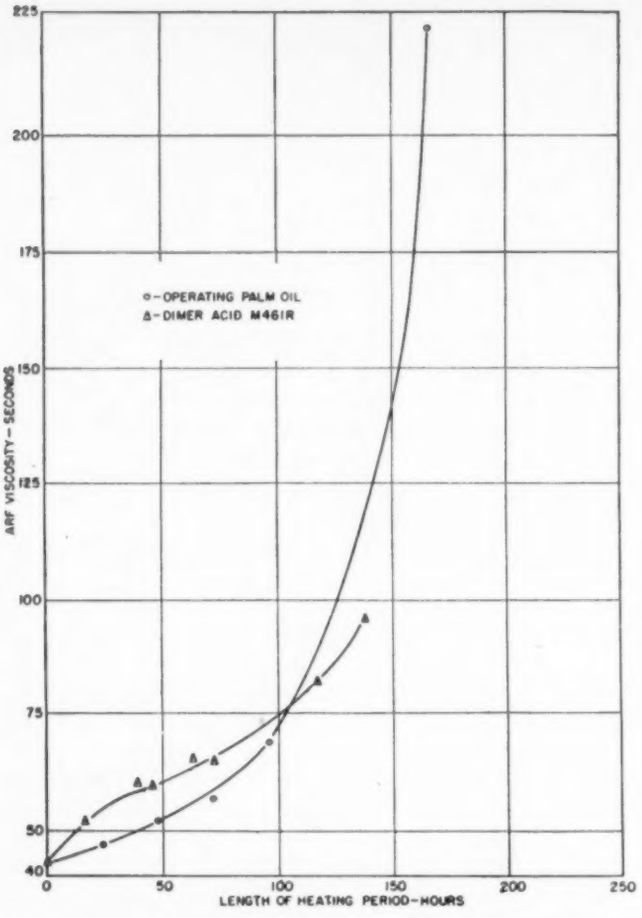


Figure 2 — ARF viscosity of tinning oil vs. time at 465 F. The curve for dimer acid is above that of palm oil until after 100 hours of heating. Then palm oil becomes almost solid.

4. Hydrogenated fish oil and hydrogenated cottonseed oil have been used as palm oil substitutes, but have not been widely accepted.
5. There was almost no information as to why one experimental oil worked and another did not.

EXPERIMENTAL WORK

Most of the successful work on palm oil substitutes has been carried out on materials whose composition and properties were similar to those of palm oil. This experimental work was primarily empirical, consisting of weight loss tests and full scale production trials. In this project it appeared desirable first to analyze the specific action of palm oil and determine which properties were important as far as the tinning action was concerned.

It is common practice in the tin house to discard palm oil when its viscosity rises above a specified control point. From oil consumption figures furnished by some of the mills, it was estimated that about one-third of the palm oil consumption is due to volatile losses. Consequently, these two points were studied first in an attempt to find a low volatile substance, which would not increase in viscosity unduly on prolonged heating at tin pot temperatures.

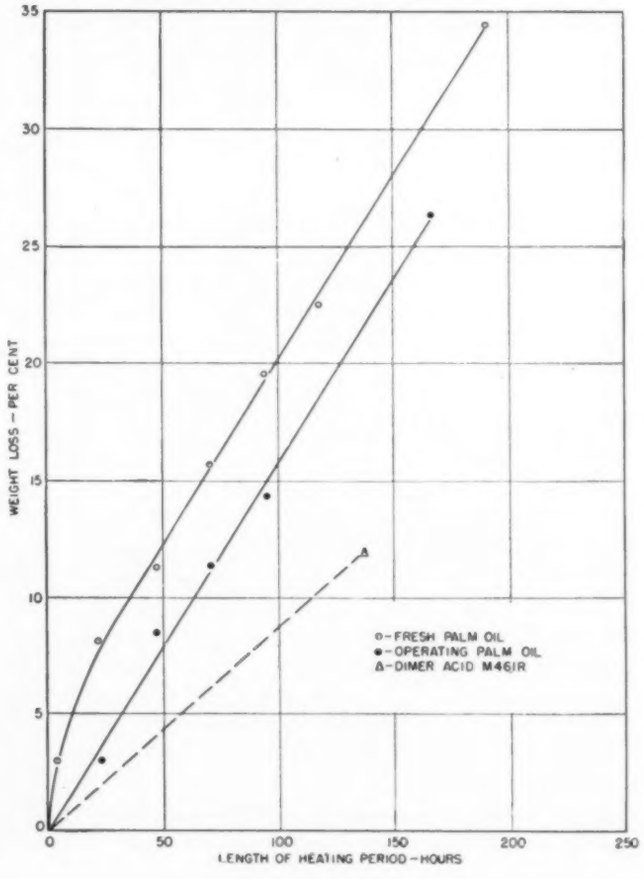
Figure 2 indicates the rise in viscosity of experimental tinning oils with time at 465 F in comparison with palm oil. Figure 3 represents the weight loss of these same materials over the same test period. It should be pointed out that these data were taken on oils to which no additions were made. In production tinning, new oil is constantly being added to make up volatilization losses; consequently more volatile oils appear in production to have better viscosity stability than indicated by the above test because of the additions in service.

Viscosity and volatility tests by themselves are insufficient to establish the excellence of a tinning oil. One of the essential requirements is that the oil drain or drip readily from the sheet. Palm oil appears to drain more or less completely from the sheet in a coherent mass, leaving a bright tin surface, while mineral oil, for example, drains smoothly to a thin continuous layer, which remains on the sheet. As palm oil becomes more and more exhausted, it is seen to cling to the sheet to a greater extent; near the end of its life it does not dewet, or break into drops, to leave a bright tin surface. This tendency is accompanied by a depletion of the free fatty acids in the palm oil.

The following significant observations were made from experiments with the petri dish test which was developed to measure dewetting.

1. All materials which were active dewetting oils had a carboxyl group or decomposed with heat to give compounds having a carboxyl group.
2. Dewetting slowly ceased in an atmosphere of nitrogen, only to resume when oxygen was readmitted.

Figure 3 — Weight loss of tinning oils vs. time at 465 F. Palm oil loses weight very rapidly upon heating at elevated temperatures. The original loss, as indicated by fresh palm oil, is very high because of the high volatility of the initial free fatty acids.



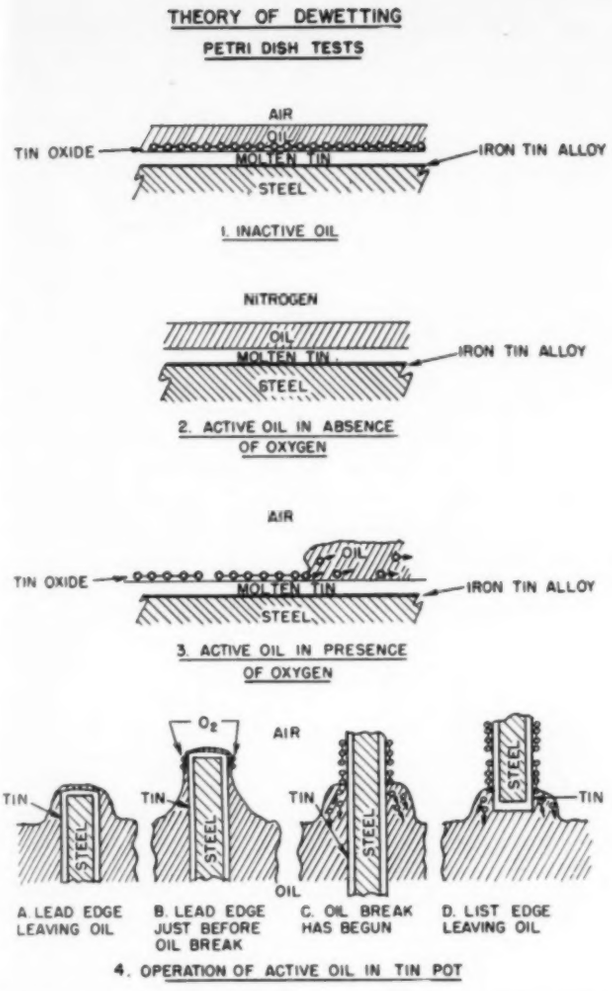


Figure 4 — Dewetting action in the petri dish test and in actual operation. The first three sketches represent various phases of dewetting in the petri dish test. The last represents the "oil break" as the sheet of tin plate progressively emerges from the oil pot.

3. Dewetting ceased when aluminum or other active deoxidizers were added to molten tin.
4. Dewetting stopped when the tin solidified.
5. Free fatty acids, for example, stearic acid, did not react chemically with the tin oxide, but did attack molten tin to form tin soaps.

From these and other observations a theory of tinning oil action was evolved. An active oil, one with a carboxyl group, has a strong physical affinity for tin oxide and a powerful dispersing action on it. In the petri dish test, as a thin film of oxide forms on the open spot of molten tin, the oil attempts to flow out across it. However, the combination of the cohesive force in the main body of oil, the dispersibility of the oxide film in the oil, and the low friction between oxide and molten tin, results in the film being pulled under the body of oil and dispersed.

The action of oil attempting to run out on the oxide film, which breaks and slides under it, gives the appearance of a negative contact angle between oil and molten tin (Figure 4). In spite of appearances, an active oil actually wets molten tin. If the petri dish is blanketed with nitrogen, the action gradually stops as the oxygen is displaced, and the oxide film stops forming, thus permitting the oil to cover the molten tin completely. As soon as oxygen re-enters the system, the action resumes.

The dewetting action is dependent upon the formation of tin oxide. Aluminum, for example, dissolved in the tin forms instead of an Al_2O_3 film, which has different characteristics from the tin oxide. With aluminum dissolved in tin, no dewetting action occurs even with the most active tinning oils.

When the tin solidifies, the oxide film can no longer slide over the surface, and the oil covers the surface completely. The action of the oil appears to be physical rather than chemical, in that the relatively stable tin oxide when on solid tin is not attacked but when on molten tin is absorbed by the oil and physically dispersed.

Apply the dewetting theory to hot dip tinning, the layer of oil drains from the sheet until it is sufficiently attenuated for oxygen to diffuse through it to the molten tin. Once the oil break has started, it proceeds rapidly, for the instantaneous oxidation of the molten tin exposed to air continually forces a negative contact angle between the tin and the oil. This theory is confirmed to some extent by the observation that, even with very low break oils in the tin pot, several inches of the lead edge of the sheet may emerge from the oil before the break occurs. The oil drainage proceeds by a tin oxide-tin—or possibly tin soap—shear rather than by the shear of one oil layer over another, as is true of mineral oil drainage.

After an extensive series of tests with the petri dish, it was established that the carboxyl group was essential for an active oil. All the fatty acids contain this group, and should serve as tinning oils if it were not for their high volatility. For example, most of the initial free fatty acids in palm oil are volatilized at the first heating. In fact, palm oil would not be a satisfactory tinning oil if it were not for the replenishment of fatty acid by the decomposition of its glycerides. These glycerides decompose slowly under heat to release free fatty acid, so that an equilibrium is reached between fatty acid volatilization and replenishment by glyceride breakdown. Since additions of new oil replenish the glyceride, this balance is maintained throughout the useful life of palm oil.

FORMULATION AND TEST OF A TINNING OIL

From the experimental requirement that a tinning oil have a carboxyl group and the operating requirements that the oil have a high flash point and low volatility, an oil, dimerized linoleic acid (dimer acid), was selected from the many tested by the petri dish test. This material is a fatty acid product, only recently available in quantity. It is made from common vegetable oils by heating under pressure in contact with steam. The residue consists of pure fatty acids, dimerized linoleic acid, and a small percentage of trimers and higher polymers. The dimerized acid, separated by distillation, consist of two molecules of linoleic acid, linked together. It is substantially 100 per cent free fatty acid. By virtue of its molecular structure, the material has a high flash point—600 F as compared to about 470 F for palm oil—and a volatility about one-third that of palm

oil. Because the dimer acid lasted about seven times as long as palm oil in the petri dish test, and since its price is in line with the present price of palm oil, it was selected for further test.

A small scale tin pot obtained from the Jones & Laughlin Steel Corp. was set up for testing experimental oils. Palm oil was run in the experimental pot for several weeks to give a standard for comparison. Dimerized linoleic acid performed quite well for about two weeks in a test in the model tin pot held intermittently at temperature. At the end of that time, it was starting to drag out somewhat and the viscosity had increased. This was not considered important at the time, for during that period almost no new oil had been added, whereas with palm oil considerable oil replacement had been made during a similar test period.

MILL TESTS

Dimerized linoleic acid was tested in a full scale mill run at the Jones & Laughlin Steel Corp. The oil, which is essentially water free, was dumped without preheating directly into the oil pot of the stack. The oil fulfilled test indications of low volatility; there was relatively little smoke or odor around the stack.

When everything was running smoothly on the second and third day of the test, the oil break was at the oil level, and sheet came from the single stage wet washer with less oil than sheets made with palm oil normally come from the branner. With this low oil break, the veining pattern of the sheet was very uniform, showing short vertical lines with no "housetops" or "branches." However, the operators could not get the tin coating weight down to the proper value. Under equilibrium conditions when bright appearing plate was being produced, satisfactory cleaning was accomplished except for a streak of oil in the uneven areas at the list edge, the edge of the sheet leaving the pot last.

Unfortunately, this oil, which is quite viscous at lower temperatures, proved impossible to remove by branning if any excessive quantity were dragged out by the plate. The first sheets, with their imperfect tin layer, dragged quantities of oil into the catcher rolls, which then printed oil onto the following sheets. The oil, being exceedingly viscous, did not emulsify readily in the wet washer and would not bran off.

During the second week of operation, the tinning machine was changed, and the coating weight was readily adjusted to the desired value. By this time the viscosity, as measured at pot temperatures, had increased sharply. The oil break began to rise, until it dragged into the catcher rolls. The oil was now too viscous to drain thin enough for an oil break to start; no break occurred even though the coil was still quite active in the petri dish test.

The high viscosity and high dragout of the dimer acid in the second week of operation made the cleaning problem very difficult with the existing equipment. The dimer acid, being 100 per cent fatty acid, saponifies very readily, but because of its high viscosity, it emulsifies with difficulty. Palm oil, even when it drags out in quantities, is rapidly removed in the wet washer by emulsification and the mechanical operation of the scrubbers, and the balance can be branned off because of its relatively low viscosity at branner temperatures. If 100 per cent removal of the tinning oil by wet washing were desired, dimer acid (because it is easily saponified) could be removed more completely than palm oil, but existing equipment would have to be redesigned for this operation.

Because of the low volatility of the dimer acid and the relatively small amount of plate produced, the rate of depletion of the oil was very low over a period when an appreciable amount of fresh palm oil would have been added to an operating stack. Perhaps a regular bailout and replenishment schedule would have avoided the excessive viscosity increase. However, this was not tried because it was felt that if dimerized linoleic acid was to be economically successful, this 100 per cent free fatty acid material should offer an unusually long life: the necessity for discard would cancel many of its advantages.

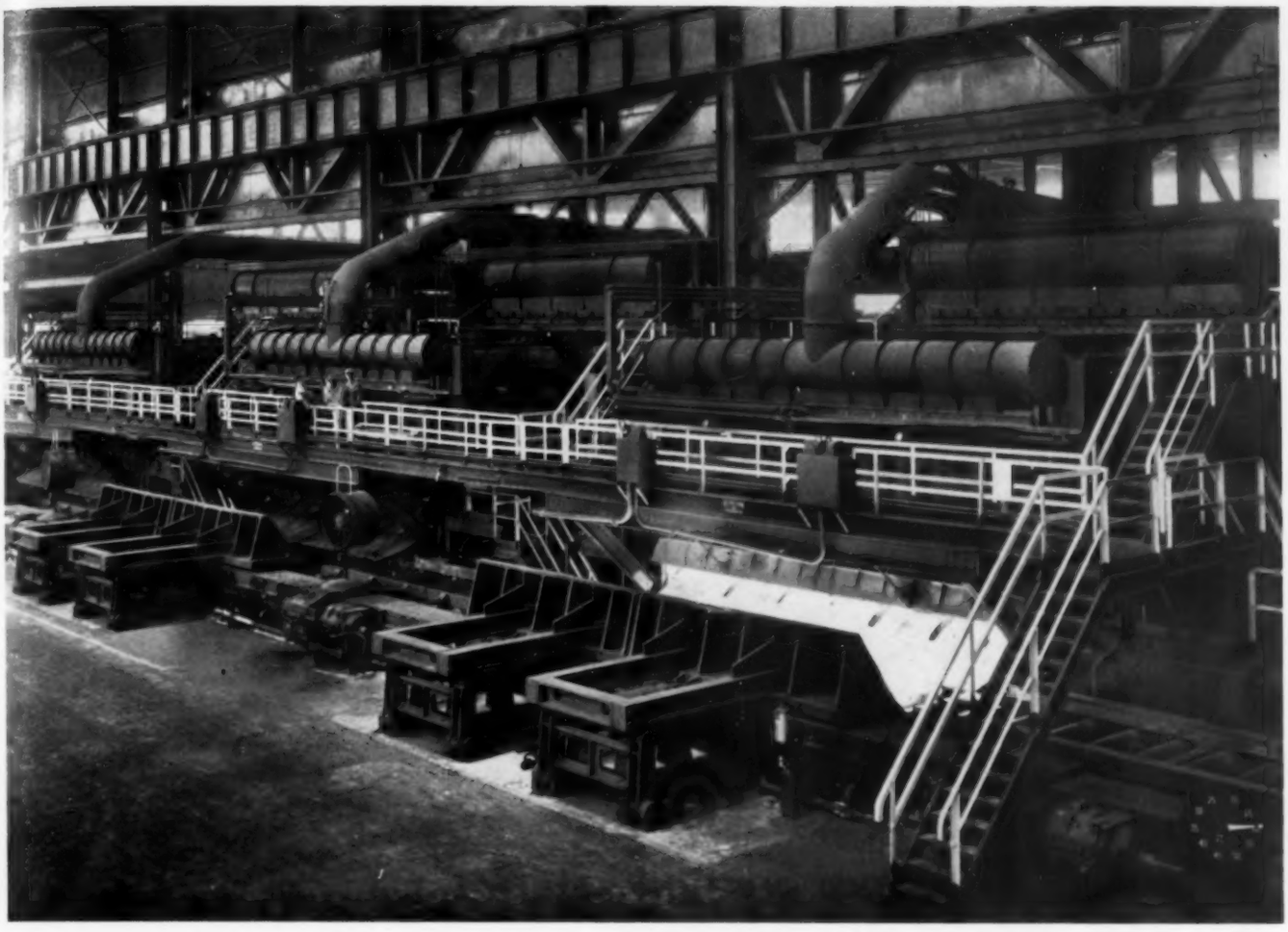
CONCLUSIONS

It is a difficult problem to formulate or discover a radically different oil which will take the place of palm oil, doing an equivalent or better job, in equipment specifically designed for palm oil. Although much information remains to be obtained, the following tentative conclusions may be drawn.

1. A tinning oil should have a free carboxyl group, low volatility, and low viscosity at pot temperatures as well as at 150 to 250 F. If the elevated temperature viscosity is too high, no break will occur. If the low temperature viscosity is too high, the sheet will be difficult to clean.
2. The petri dish test is satisfactory as a screening test for selecting potential tinning oils.
3. Satisfactory tin plate can be made with 100 per cent free fatty acid, if the acid is not too volatile or viscous.
4. A theory explaining the oil break has been advanced in the section on experimental work of this report.

Dimerized linoleic acid, aside from its viscosity, made a good showing in the mill test. Consequently, the subsequent work has been devoted to a study of dimerized acid materials. Three general lines of approach will be followed:

1. Correction of undesirable viscosity characteristics of dimer acid by the use of addition agents to improve low temperature viscosity and to retard heat-bodying.
2. Examination of various esterified dimer acid products which are known to have satisfactory low temperature viscosity characteristics and which give promise of good resistance to heat-bodying.
3. Examination of certain little known materials such as jojoba oil, which on the basis of the known composition should have highly desirable properties. This material is not produced in quantity, but the potential supply in Mexico is believed to be adequate should a demand arise.



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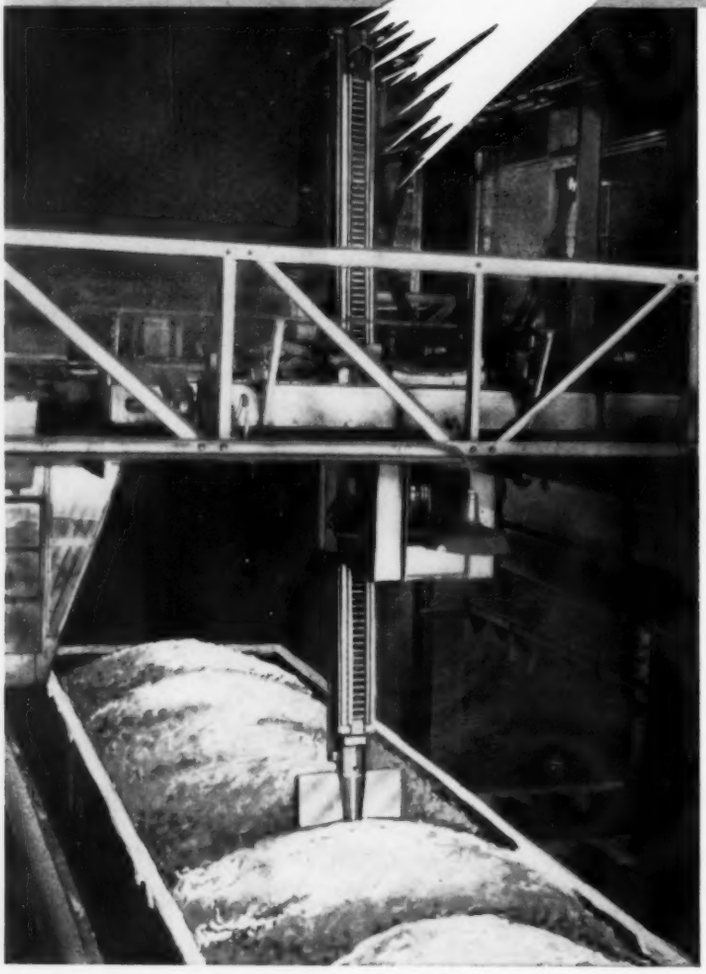

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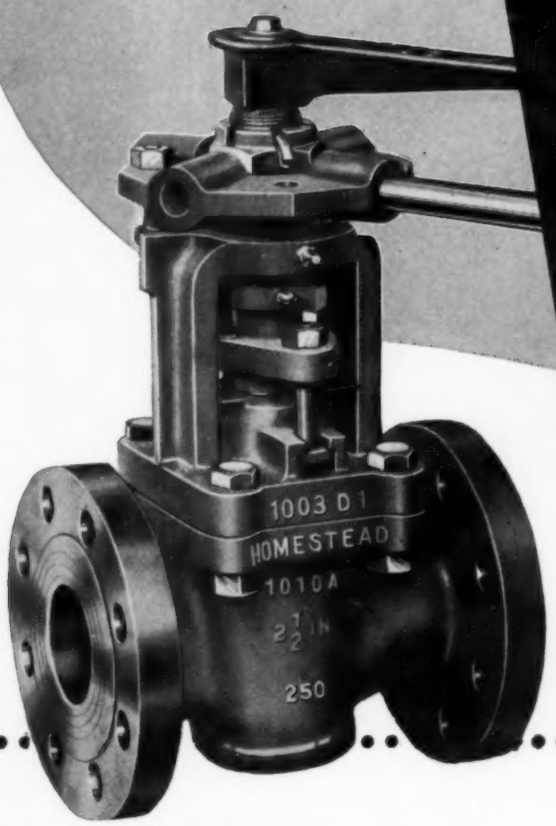

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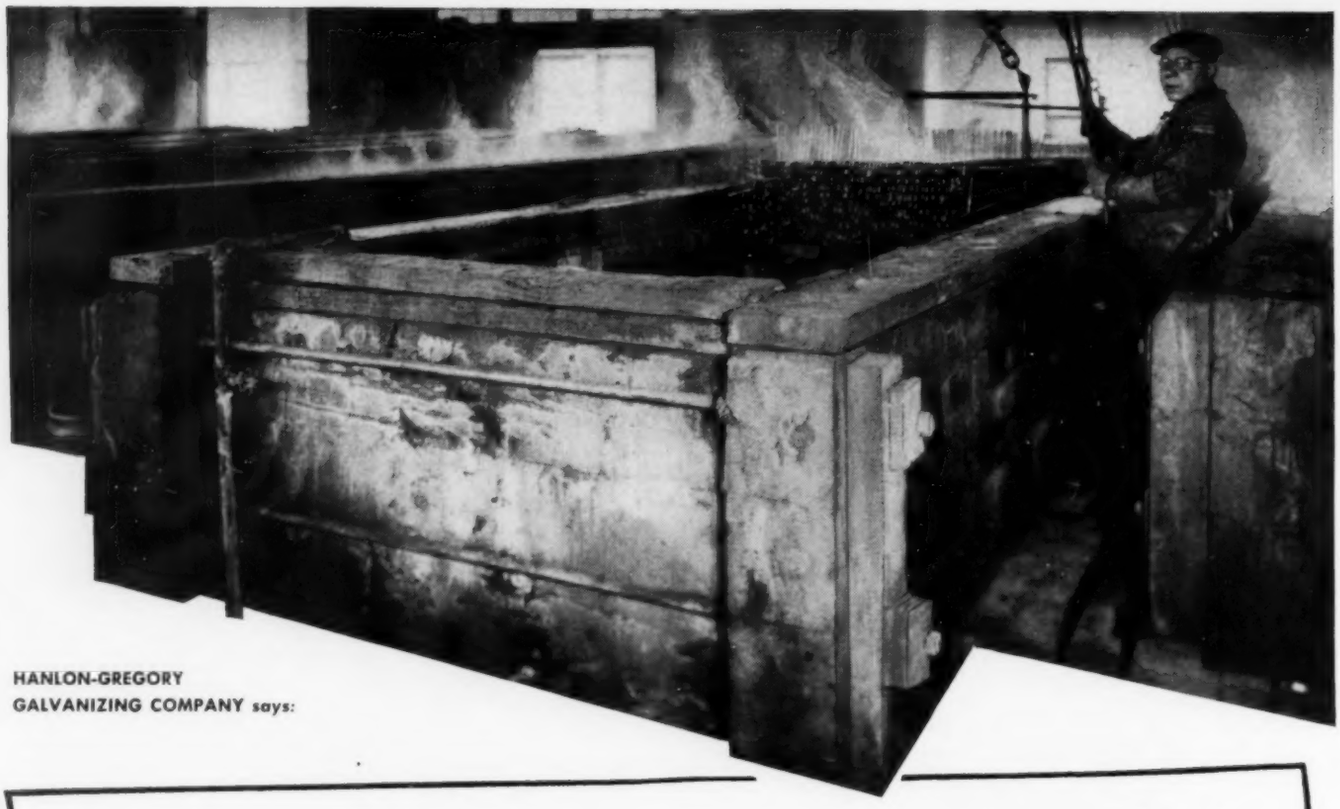

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By L. W. BENNETT
Storage Battery Division
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▲ The Atlantic Steel Co., Atlanta, Ga., has developed a material-handling system around the unit-load principle which is ingenious in that it permits handling a wide variety of sizes and shapes as unit loads both skidded and unskidded.

The pallet-fork-truck system, with several modifications, has been found best suited for the handling of the work through production, storage and shipping. Included among the various types of material handled are sheared billets, coiled wire, bundled wire, kegged nails, rivets, angles and fencing.

In addition to using the accepted methods of handling on pallets and skids, the management has developed its own methods for handling awkward items as unit loads.

A good example of this may be seen in the handling of bale tie wire which, when packaged, consists of a 9 ft, 185-lb bundle of individual strands. Fifteen of these bundles are made into a unit load for handling economically, by the simple expedient of looping a strand of wire around each end of the load to form a sling. The loads can then be carried from the packaging operation to storage, and eventually to weighing and shipping by a fork-lift truck equipped with a long ram in place of the conventional fork. The bundles are carried on the ram as a sling load and, when shipped, are delivered directly to point of storage in outgoing carrier where they are stacked three high.

Another unusual example of unit-load handling by battery-industrial truck is found at the other end of the production line where ingots weighing 3800 lb each are tiered in storage by crane truck.

Although the bulk of ingot production is carried directly to the soaking pits by overhead traveling crane after they are stripped from the molds, a portion of this production is held in temporary storage for use at those times when the open hearth furnaces are down. These ingots are handled in single units by a battery-crane truck which picks them up from beneath the craneway and tiers them eight-high in an adjacent storage area. They are subsequently delivered to production by the same truck which carries them directly to the soaking pits for reheating preparatory to being rolled into billets.

Billets are likewise handled unskidded as unit loads from shears to hoop mill. Following hot rolling in the blooming mill, they are sheared to seven-foot lengths and made into bundles at the shears.

Three separate handlings are entailed in moving the billets from the shears to the next operation—a condition which makes the use of battery-powered fork-lift trucks particularly well suited for this phase of the work.

Figure 1 — Smooth operation is essential in stacking ingots in storage. These ingots, weighing 3800 lb each, comprise a cushion stock between the open hearths and the soaking pits.

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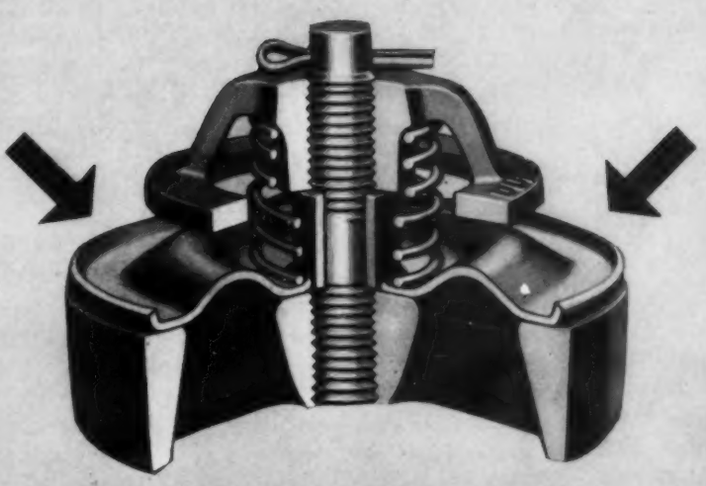

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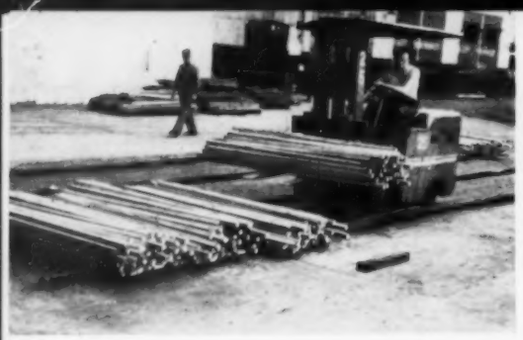


Figure 2 — After the rod is drawn to wire it is assembled, in coil form, on special skid racks then carried to the nailing machines.

As the billets drop from the shears, they are accumulated on wooden blocks which support them at each end and provide under clearance for the fork. Sufficient billets to make a bundle weighing approximately 3000 lb are bound together into a unit load by wire and are then carried to the next operation—weighing. Truck and load are weighed together by the operator after which the load is set down in a temporary storage area.

To facilitate set-down and pick-up by the fork-lift truck, the billets are deposited on wooden runners which support them at each end and provide under clearance as did the blocks at the shears. As the work is needed at the hoop mill the loads are picked up, still in bundles, and carried to the entry end of the mill where the truck elevates them to an inclined rack which feeds into the furnace. Bulk is broken at this point by cutting the wires which bind the bundles together.

The billets undergo changes in size and shape at the hoop mill and emerge as "rod" which, after further processing, is carried in the form of coils to the draw-benches where it is made into wire. Here again the unit-load principle has been adopted for the handling of wire which, after emerging from the dies, is made up into coils and accumulated on specially constructed skid racks for handling to the next operation. It is interesting to note that these skid racks are replacing live skids which, for many years, were moved manually from the drawing benches to the next operation, nail making. The management, satisfied that power trucking can do the job faster, safer, and with no waste of man power, is in the process of changing over to skid racks; a project that is three-quarters completed.

Figure 3 — Finished nails, packed in 100-lb kegs, are accumulated on pallets and tiered to ceiling height in this storage area. Thirty-two kegs are accommodated on one pallet.

Following the drawing operation, the work is carried in unit loads to any one of several different operations where it is made into various products such as fencing, bale tie wire, bright wire, galvanized wire, etc. For example a large portion of the wire is delivered to the nailing department where it is spotted at the nailers convenient to the operators. Nails are discharged from the machines into tote pans which are accumulated in pallet loads and delivered to the tumbling machines.

Following the tumbling operation the nails are again accumulated in tote pans if they are to be galvanized or in kegs if they are to be shipped without further processing. In either case, the containers remain on pallets and are handled as unit loads.

Finished nails, whether plain or galvanized, are packed in 100-lb kegs and stored on pallets, 32 kegs per pallet. Pallets are 48 in. by 48 in. and are constructed of 4 in. by 4 in. runners with 2 in by 4 in. decking. In storage they are tiered to ceiling height by 4000 lb fork-lift trucks. Production averages 43,000 kegs of nails per month. When scheduled for shipping, they are detiered and delivered, still in unit loads, directly to point of storage in box cars.

Warehousing and shipping operations have been completely mechanized. At the 500 ft long wire-products warehouse, every production item that can possibly be handled as a unit load is stored either on double-faced pallets or skid bins or is stacked unskidded in such a manner as to permit handling by the pallet-fork truck system.

In addition to bale tie wire which, as previously described, is handled as a sling load, coils of bright and galvanized wire are also handled unskidded by ram truck. These coils, weighing approximately 100 lb each are stored on edge to facilitate pick up by the ram. In common with all the company's products, they are weighed before being shipped and are delivered, 15 at a time, directly to point of storage in outgoing freight car.

Although no sheet stock is produced at this plant, the company serves as a distribution point for steel in this form. Sheets measuring up to 4 ft by 10 ft are stacked in bundles with dunnage between and the bundles handled as unskidded loads by fork-lift trucks.

A railroad spur truck having accommodations for seven box cars extends along the length of the wire-products warehouse. Occasionally, in loading a car, the distance from the lading to the car is greater than the economical range of fork-truck oper-

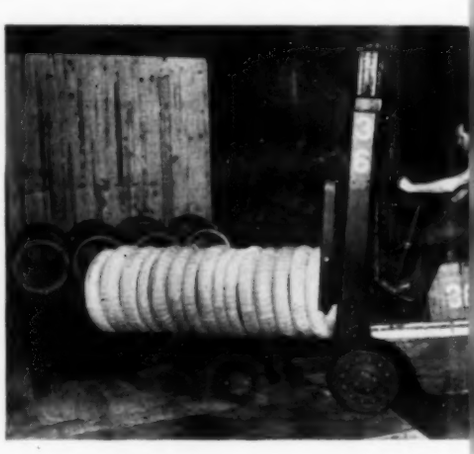


Figure 4 — Coils of wire are carried by ram truck over a bridge plate directly to point of storage in outgoing box cars.

ation. On these occasions the load, providing it is palletized, is transferred to a motorized hand truck for delivery to the carrier.

This "walkie" truck together with a conventional 2000-lb fork-lift truck also operates on the second story of the warehouse. Material is carried to or from the upper story on an elevator of sufficient capacity to accommodate both truck and load.

Batteries for the trucks used in production departments are Edison 30 cell Type C8s and 30 cell Type D8s; a 10-cell Type C5 powers the motorized hand truck. The plant is equipped with spare batteries for two-shift operation. Charging current is supplied by rectifiers. Solution height is checked daily and the batteries are watered with the Edison electric filling outfit.

P-G *Steel Grid Resistors for* BETTER PERFORMANCE

...WITH *Low Cost Maintenance!*

Rugged

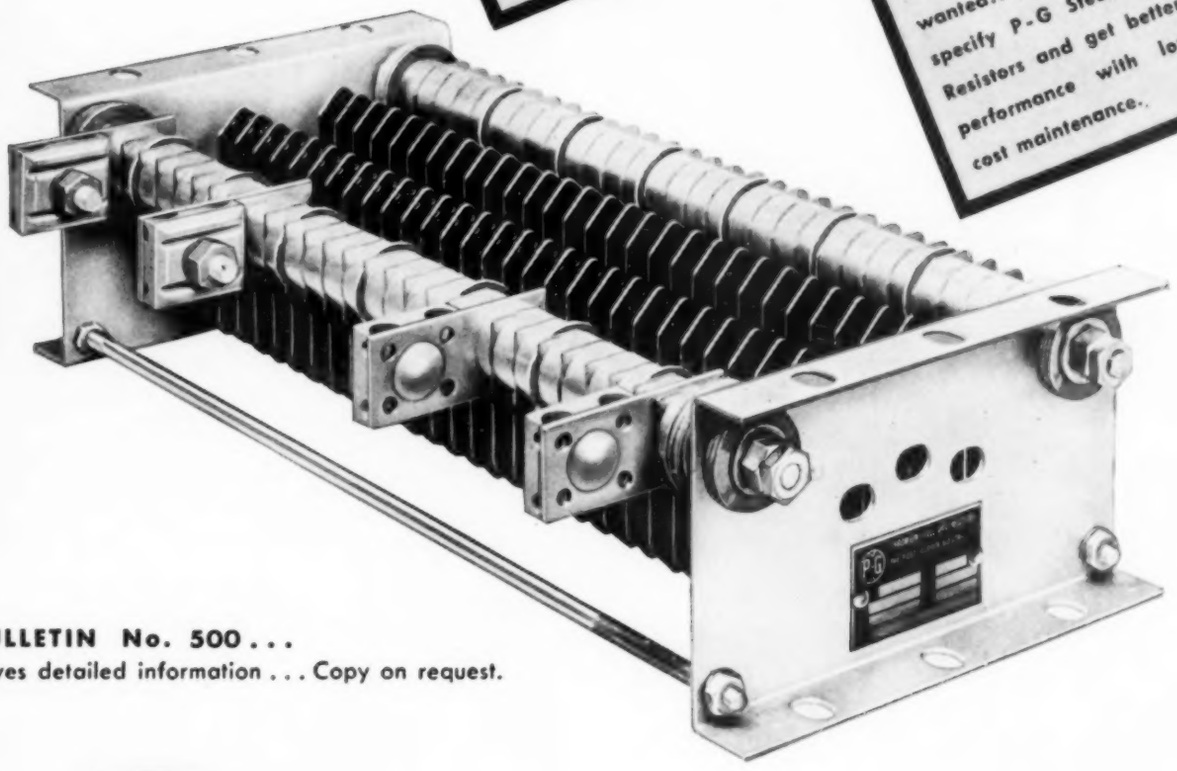
Built of Steel and Mica —nothing to break. Light in weight and dependable. Remarkably constant resistance values regardless of temperature or age.

Original Grid Design

Provides a shape assuring maximum ventilation. Heat is evenly distributed. With all parts of grid equally exposed, heat is rapidly dissipated.

For any job

Where constant "trouble free" resistor service is wanted...you can safely specify P-G Steel Grid Resistors and get better performance with low cost maintenance.



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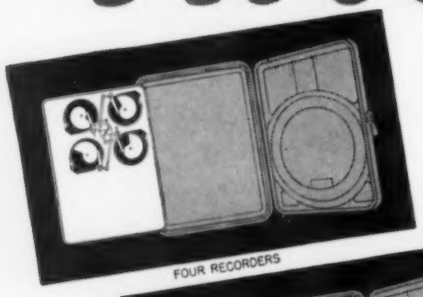
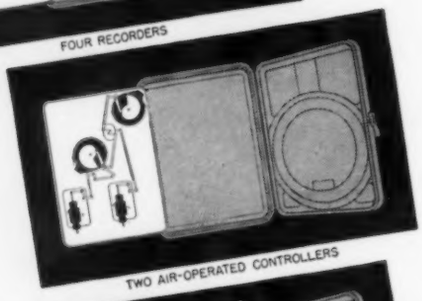
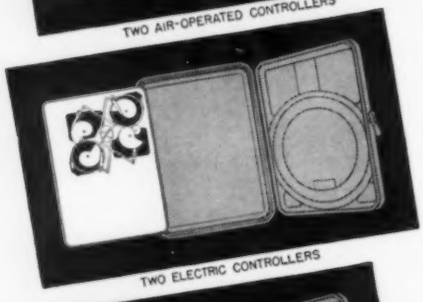
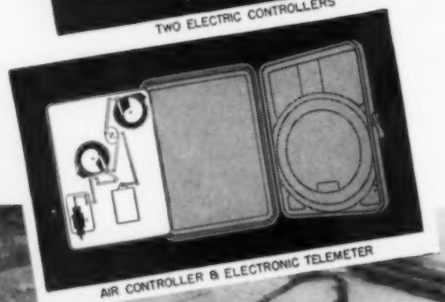

FOUR RECORDERS


TWO AIR-OPERATED CONTROLLERS


TWO ELECTRIC CONTROLLERS


AIR CONTROLLER & ELECTRONIC TELEMETER

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No matter what you process, four basic circuits and eight basic component parts will give you more than 100,000 different electronic measuring and controlling combinations. That's how Bailey has simplified controls for processing industries.

The four arrangements illustrated show how easily Bailey interchangeable parts can be used. It's no longer necessary to carry a huge stock of replacement parts for emergency control installations. When you standardize on Bailey controls you are always ready to meet changing conditions within your plant.

And with Bailey simplified controls, your maintenance costs will be less. Maintenance men quickly become familiar with Bailey controls and spend less time on maintenance and installation.

To see for yourself how you can profit with Bailey controls, write for a copy of our bulletin No. 17.

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Controls for the Iron and Steel Industry
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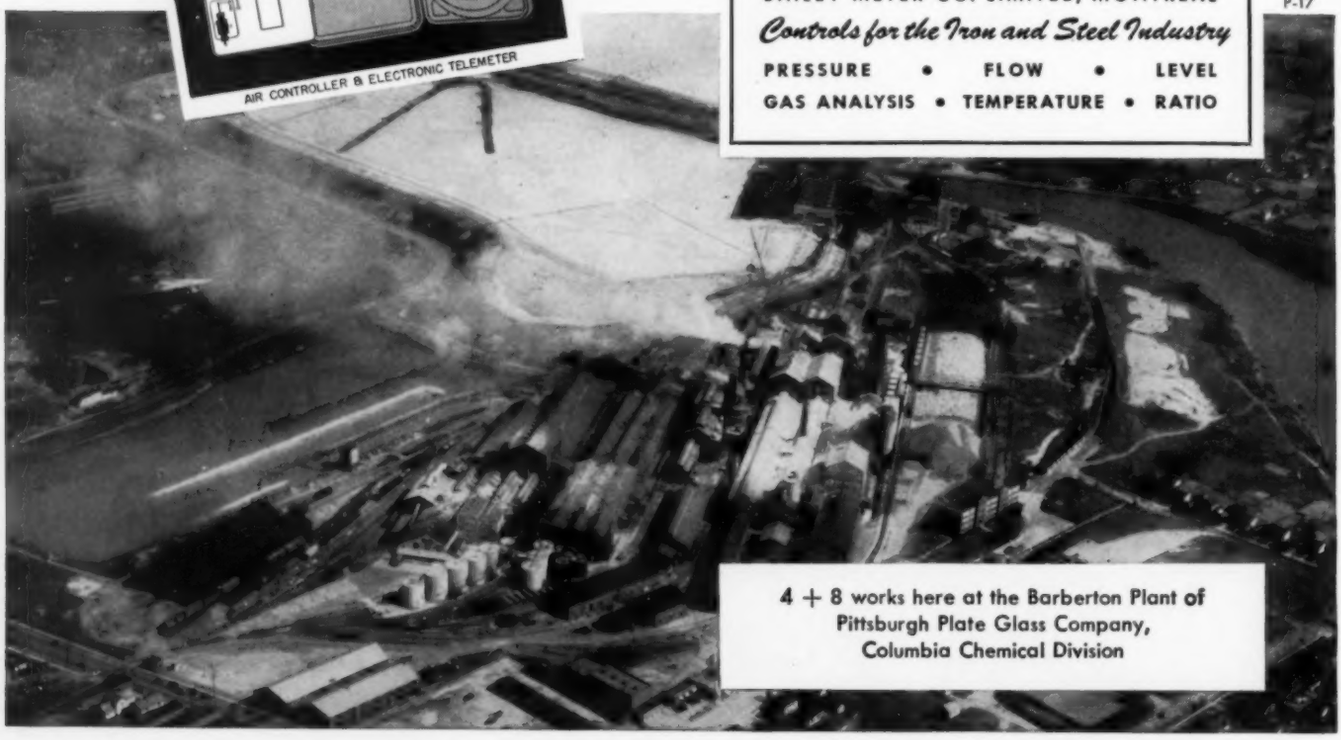
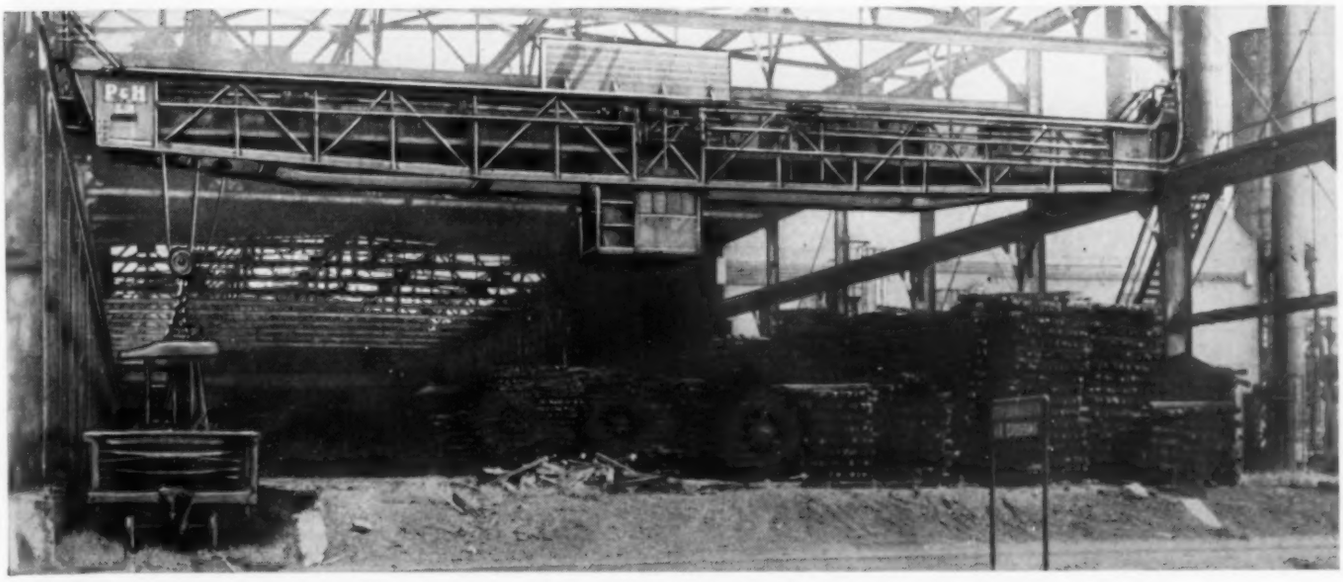
P-17

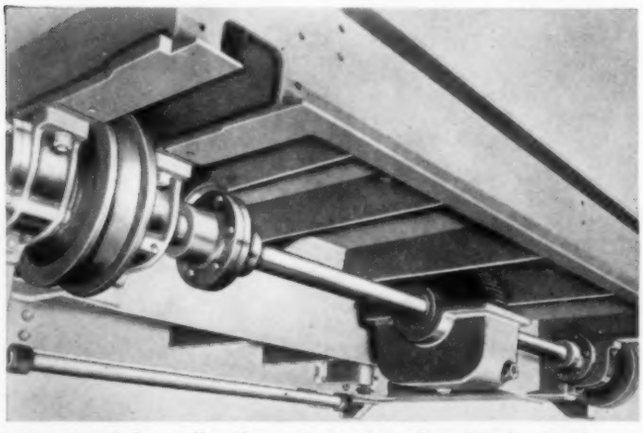


4 + 8 works here at the Barberton Plant of Pittsburgh Plate Glass Company, Columbia Chemical Division

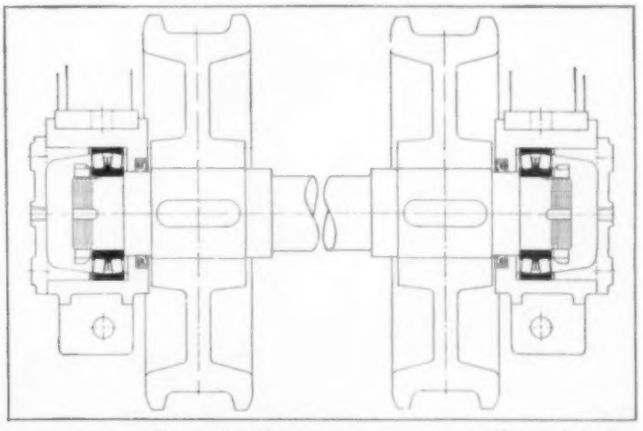
Torrington Spherical Roller Bearings keep tons on the move in Harnischfeger Travelling Cranes



Steel Mill Overhead Cranes have to move tonnage rapidly and continuously. In P & H cranes, Harnischfeger Corporation, Milwaukee, Wisconsin, puts emphasis on rugged construction and long service life of all parts. In the trolley drive of the 10-ton crane above, Torrington Spherical Roller Bearings operate efficiently with minimum maintenance.



Close-Up of the trolley drive shows the pillow blocks that house the Spherical Roller Bearings. These bearings assure accurate shaft alignment without adjustment and are readily accessible for inspection and servicing.



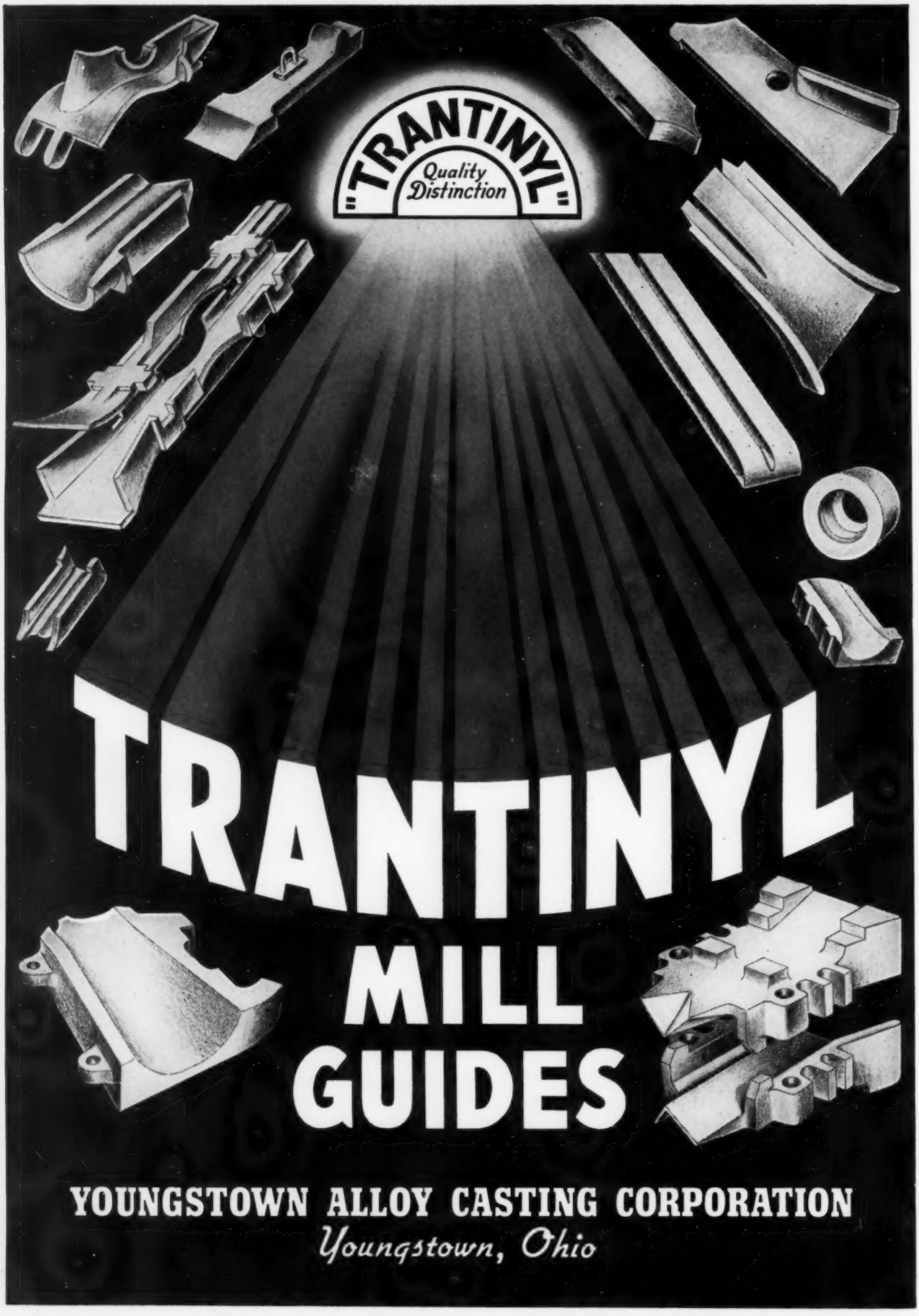
Cross-Section shows the design incorporating Spherical Roller Bearings. When loads are heaviest, and shaft deflection most likely, these self-aligning bearings afford full roller contact area for sustained high capacity and free-rolling operation.

The high capacity of Torrington Spherical Roller Bearings, unimpaired by deflection or misalignment, can be applied to improve the operation and service life of your heavy-duty equipment. Our engineers will be glad to help you in adapting them to your designs. Write us today. THE TORRINGTON COMPANY, South Bend 21, Ind., or Torrington, Conn. District offices and distributors in principal cities of United States and Canada.

TORRINGTON SPHERICAL ROLLER **BEARINGS**

Spherical Roller • Tapered Roller • Straight Roller

Needle • Ball • Needle Rollers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MORE TONS PER PASS

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BILLET EJECTORS—PINCH ROLL STANDS
SLITTERS—SPECIAL SHEARS AND GAUGES
TILTING TABLES—TRAVELING AND LIFTING TABLES
CONTINUOUS PICKLING LINES—ROLLER LEVELLERS
FURNACE CHARGING EQUIPMENT—FURNACE PUSHERS
STRIP STEEL COILERS AND REELS—SCRAP BALLERS
RAILROAD SPIKE FORMING MACHINES—ROLL LATHES
SHEET GALVANIZING LINES—WIRE PATENTING FRAMES
STRETCHER LEVELLERS—ANGLE AND SHAPE STRAIGHTENERS
ROLLING MILL TABLES—GEAR AND INDIVIDUAL MOTOR TYPES
MACHINERY BUILT TO CUSTOMER'S DESIGN AND DETAIL DRAWINGS

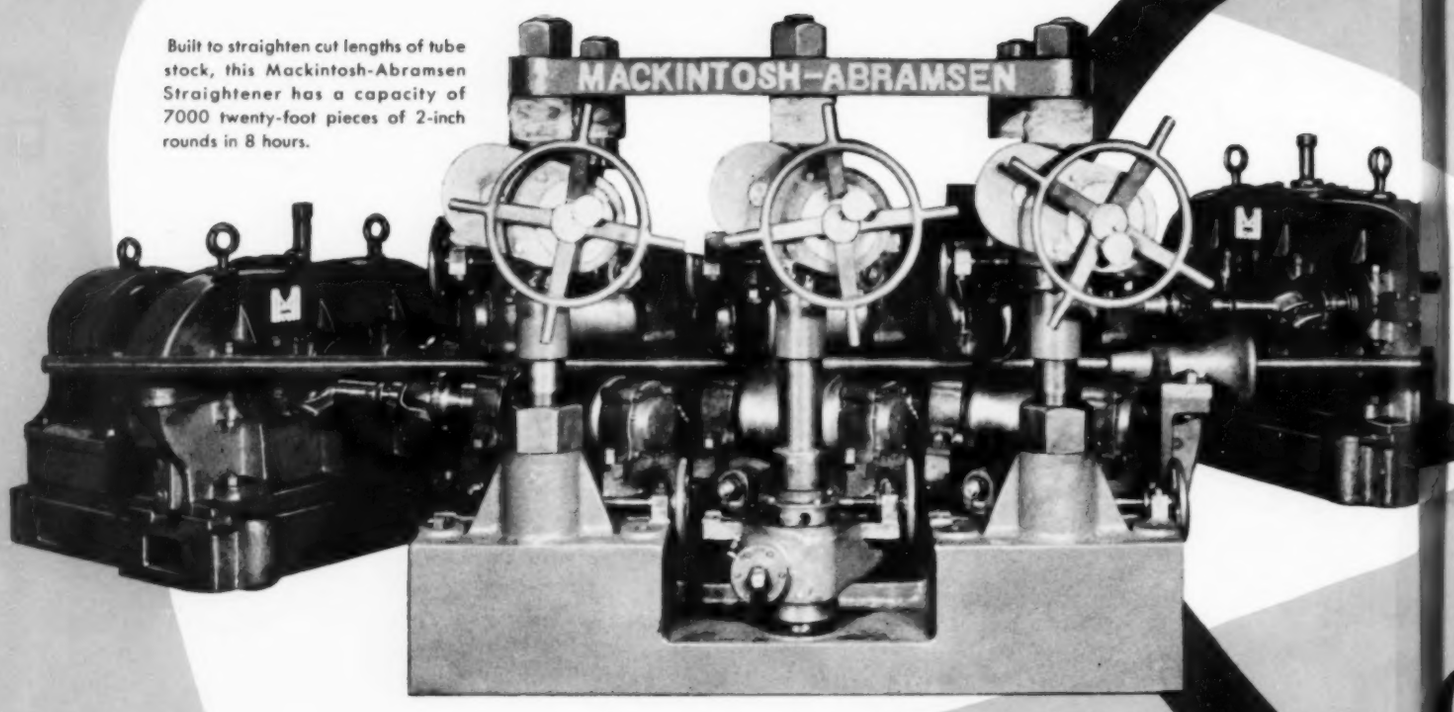
The Youngstown Foundry & Machine Co.

Youngstown, Ohio

OVER SIXTY YEARS OF SERVICE TO THE STEEL INDUSTRY

Mackintosh-Abramsen

STRAIGHTENER



Built to straighten cut lengths of tube stock, this Mackintosh-Abramsen Straightener has a capacity of 7000 twenty-foot pieces of 2-inch rounds in 8 hours.

★ **STRAIGHTENS without scoring surface**

★ **REMOVES end-hooks**

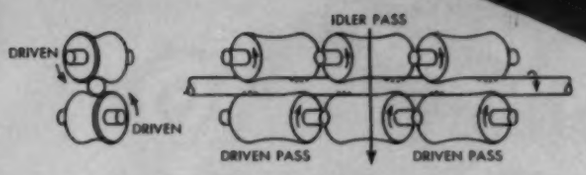
★ **POLISHES uniformly, end-to-end**

★ **SIZES bars and tubes to close tolerances**

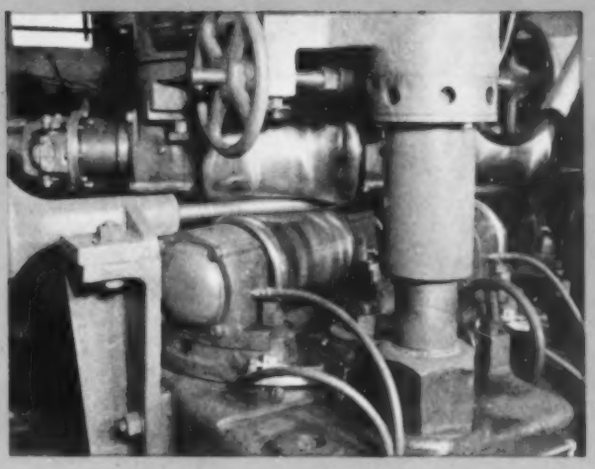
Most important fact about the Mackintosh-Abramsen Straightener is that it delivers a consumer-acceptable product—absolutely straight from end to end. To insure this maximum product straightness individual rolls must be separately adjusted. A special feature of the Mackintosh-Abramsen Straightener is the simple mechanism for adjusting each roll independently of the others.

A modern productioneering tool for bar and tube mills, the Mackintosh-Abramsen Straightener performs a high-speed precision-finishing operation on all types of stock. The simplified, open-frame design of the Mackintosh-Abramsen Straightener requires a minimum setting-up time. Its new cradle-type roll bearing assembly permits fast roll-change. Operating economies in both man-hours and power consumption meet present-day demands for manufacturing cost-reduction.

It's always worthwhile to keep an eye on what's new at Mack-Hemp.

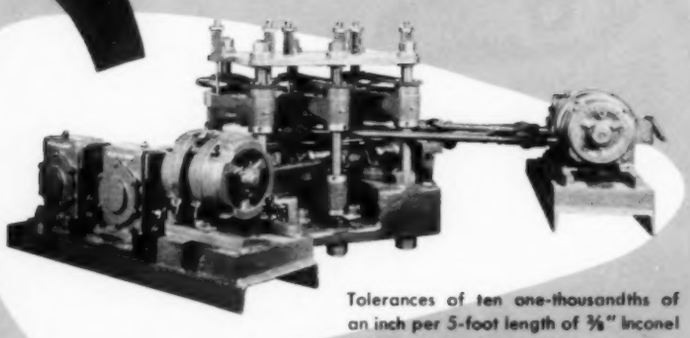


The Mackintosh-Abramsen Method—Straightening is accomplished by an offset cross roll pass between two fixed cross roll passes (patented)—No guides are required because the rolls are driven on both sides of the material which is supported by the bottom rolls. With this balanced arrangement there is no decreasing efficiency from uneven wearing of the rolls. The straightening takes place from section to section and not from point to point.



reduces finishing costs on bars and tubes

MACKINTOSH-ABRAMSEN straighteners are built in various sizes for finishing ferrous and non-ferrous tubing from 1/16" to 24" diameter, and bar stock ranging from 1/16" to 8½" diameter.



Tolerances of ten one-thousandths of an inch per 5-foot length of ⅜" Inconel Tubing, were obtained by a manufacturer of stove heating elements with this bench-model Mackintosh-Abramsen Straightener.

MACKINTOSH-HEMPHILL CO.

PITTSBURGH AND MIDLAND, PA.

Makers of the Rolls with the Striped Red Wabblers

MACKINTOSH-HEMPHILL PRODUCTS INCLUDE: Rolls . . . Steel and special alloy castings . . . completely integrated strip mills . . . heavy duty engine lathes . . . the new Mackintosh-Abramsen straighteners . . . improved Johnston patented corrugated cinder pots and slag handling equipment . . . shape straighteners . . . shears . . . levellers

Use Stainless Steel and HELIARC Welding

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"Heliarc" welding a stainless steel water tank for use in railroad passenger coach. Welds will need no further finishing.

Switch to this Combination and Save Money

Build Sales Appeal with Stainless Steel

Get Clean, Fast Welding

Cut Finishing Costs to the Bone

Switch to the "Heliarc" process for welding stainless steel. Welding is fast, distortion is low, and there is no spatter with the "Heliarc" process. No flux is used and you save cleaning costs. The welds are so smooth that many articles need no grinding or finishing at all.

Switch to stainless steel for your other products too. They will have added strength, longer life, freedom from corrosion and better appearance. You build sales appeal into your product when you weld stainless steel with "Heliarc" equipment.

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A half century of research and testing to develop the most serviceable brush characteristics for a wide range of applications has provided Speer with specifications for several thousand brush grades. Conversion of this large assortment to a smaller number, with superior operating characteristics passed down, makes Speer's standard line of carbon brushes actually the best of the best. A good reason for you to specify Speer Carbon Brushes for all your commutating jobs, whatever your requirements.

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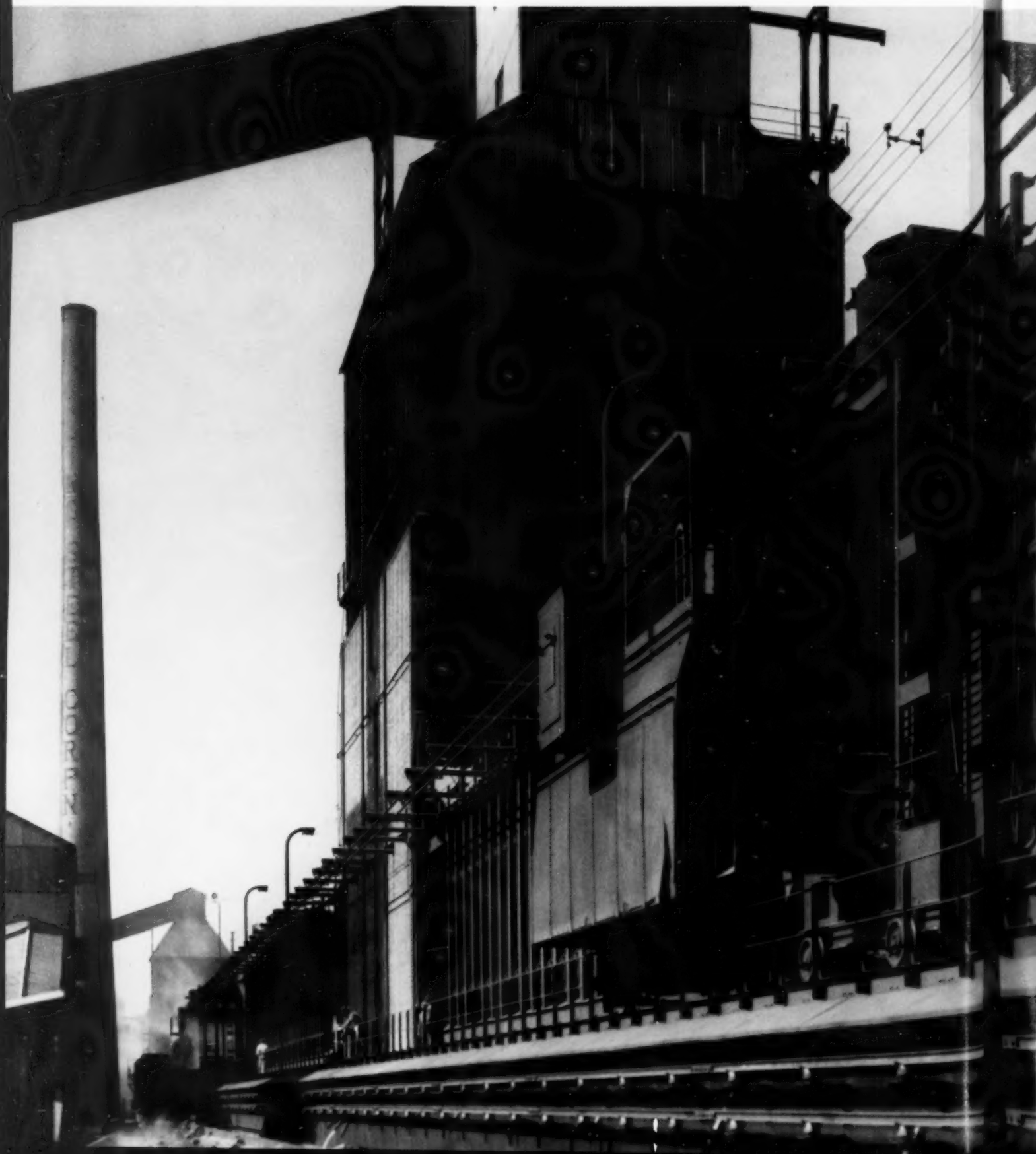
Koppers *DOUBLES* the Coke-Producing Capacity of W



Wheeling's East Steubenville Plant !

With the completion of 106 new coke ovens for the East Steubenville Plant of the Wheeling Steel Corporation, the Engineering and Construction Division of Koppers Company has *doubled* the coke-producing capacity of the plant!

Built in two batteries of 53 ovens each, these 106 ovens carbonize 2594 net tons of coal per day. This compares with a carbonizing capacity of 2500 net tons of coal per day from the 145 old Koppers-type ovens. Combined, the 251 coke ovens now carbonize 5100 net tons of coal daily . . . based on normal carbonizing capacity, *that's more than double the former coke-producing capacity of the plant.*

These new Koppers-Becker Underjet Coke Ovens are underfired with coke-oven gas and equipped with waste-gas recirculation; also, there is provision for future blast-furnace gas underfiring. Each individual oven is 40 feet, 6½ inches long, 13 feet high and 18 inches in average width, with a 3-inch taper.

In addition to designing and constructing this new coke-oven plant, Koppers engineers, in order to take care of the greatly increased coke production, extended Wheeling's Coal and Coke Handling Systems, and completely modernized the Ammonium Sulphate and Benzol Plants.

Koppers has long been recognized as the foremost builder of coke ovens in the United States. But, in *any* problem dealing with coal carbonization, Koppers engineers are specialists, and are always available for consultation and advice.

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ENGINEERING AND CONSTRUCTION DIVISION

KOPPERS COMPANY, INC.

PITTSBURGH 19, PA.

106 new Koppers-Becker Underjet Coke Ovens designed and constructed by Koppers Company, Inc., for the East Steubenville Plant of the Wheeling Steel Corporation.

DOUBLE-CHECKED IN PRODUCTION ...TROUBLE-FREE IN PERFORMANCE

Every International graphite electrode and nipple is manufactured according to rigid specification standards . . . from mixing raw materials to boring and threading the finished product, tested and checked again and again to maintain constant high quality. It is this careful control that assures trouble-free performance so characteristic of International electrodes.

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Graphite Products for Electrothermic and Electrolytic Applications.

International GRAPHITE AND ELECTRODE CORP.

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This is but one of the thousands of big cranes developed and built by Alliance. Of course, there are smaller ones, too—all sizes, in fact, to handle heavy loads of all types. For economical, dependable lifting power in your plant, let Alliance develop the equipment best suited to your company's material handling operations.

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FIRST IN CRANE DESIGN

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SPECIALISTS IN SCALE AND SLUDGE REMOVAL WITH CHEMICALS

Here's how

Chemical Scale Removal Service

SAVES TIME AND MONEY FOR STEEL PLANTS!

Steel plant operators who rely on Dowell for chemical scale removal service for heat-exchange equipment find it quick, effective, safe—and economical. Blast furnace cooling systems, for example, may be cleaned *without shut down*—and real savings result!

Dowell engineers fill the equipment to be cleaned with specially selected liquid solvents designed to dissolve and disintegrate scale and sludge deposits. Dismantling is unnecessary; down time is reduced to a minimum. Every step of the work is planned and carried out by trained Dowell personnel—and Dowell supplies the truck-mounted tanks, pumps, heaters, mixers and control equipment.

Get the *facts*. Call the nearest Dowell office for estimates and full data on chemical cleaning service for:

- Blast furnaces, open hearth furnaces
- Boilers, condensers, economizers, feed water systems
- Engine, compressor and blower jackets
- Rolling mill cooling systems
- Locomotive boilers
- Water wells, water lines and piping
- Coke plants—scrubbers, coolers, precipitators, gas lines
- Building heating, air conditioning, steam and water distribution systems

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Richmond 19	St. Louis 8	Ft. Worth 2	Midland, Texas
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DOWELL

A SERVICE ORGANIZATION

Date-line Diary...

July 2

▲ Steel operations in the Pittsburgh district are scheduled at a new low for the coming week at 55.1 per cent of capacity. Decline is accentuated by holiday and vacation shutdowns.

July 4

▲ Soft coal miners are starting a three day work week effective this week. Operations will be performed on Monday, Tuesday and Wednesday until Lewis orders a five day week.

July 5

▲ The various shippers advisory boards estimate that freight loadings in the third quarter will be about 7½ per cent below the corresponding 1948 period.

▲ Based on reports of companies having 94 per cent of capacity of the industry, the operating rate of the steel industry is scheduled to be 61.2 per cent of capacity for the week beginning July 5, 1949. This is equivalent to 1,128,200 tons of ingots and castings compared with 1,473,000 tons one week ago.

July 6

▲ The National Advisory Council recommended that some West European Nations should devalue their currencies without naming the nations involved.

▲ U. S. exports according to the Department of Commerce dropped $71,000,000 from April to May to a value of $1,077,000,000.

▲ Benjamin F. Fairless, president United States Steel, announced that after days of collective bargaining that the United States Steel Corp. had declined a proposal of the United Steelworkers of America for an increase of pay.

July 7

▲ American Iron and Steel Institute announced that employment in the steel industry declined during May, but still remained higher than May 1948. The number employed was 637,400 in May compared with 646,600 in April. Average hourly earnings in May were $1.697 compared with $1.688 in April.

▲ Copper prices went up 1¢ from 16¢ to 17¢ a lb.

▲ Department of Commerce announced that construction outlays the first half of 1949 were $8,452,000,000 for a new six month record. Private spending dipped slightly while public construction increased.

▲ The Federal Mediation's director Cyrus Ching called officials of the CIO and U. S. Steel Corp. to a joint meeting in Washington in an effort to prevent the steel strike scheduled for July 15.

July 8

▲ The Allegheny Ludlum Steel Corp. announced that melting operations have begun in their new 70-ton melting furnace.

▲ Department of Commerce estimates that business inventories at the end of May were $52,538,000,000 or a drop of $1,224,000,000.

▲ The Edison Electric Institute reported that sales of electricity to industrial plants in May 1949 were 1.3 per cent below 1948.

▲ American Railway Car Institute announced that freight car deliveries in June were 9,121. Orders during June totaled 153 and left a backlog on July 1st of 42,813.

▲ Lead prices went up 1¢ from 12¢ to 13¢ a lb.

July 9

▲ The Treasury Department reported that series E savings bond sales in the first half of 1949 totaled $2,250,000,000 up 2½ per cent from a year ago.

July 10

▲ Federal Power Commission reports that energy production by electric utilities in May totaled more than 23,300,000,000 kwhr or the highest ever recorded for the month and 0.6 per cent above April. Installed capacity of the plants increased 335,539 kw in May for a new capacity of 58,201,883 kw.

July 11

▲ Based on reports of companies having 94 per cent of the steel capacity of the industry, the operating rate is scheduled to be 77.8 per cent of capacity for the week beginning July 11, 1949. This is equivalent to 1,434,300 tons of steel ingots and castings compared with 1,128,200 tons one week ago.

▲ George H. Love, president of Pittsburgh Consolidated Coal Co., predicted that the three day work week in the coal mines would result in higher coal prices.

▲ President Truman gave up his demand for a $4,000,000,000 tax boost.

July 12

▲ Refined copper prices went up to 17⅝¢ a lb for a raise of ⅝ of a cent.

▲ Department of Agriculture estimated that the wheat crop this year would be 1,188,000,000 bu or 148,000,000 less than their previous estimates.

▲ In answer to a request of President Truman that the steel industry submit their dispute with the Union to a fact finding board, Benjamin F. Fairless, president of U. S. Steel Corp., stated that this should not be done and that the dispute should be settled under the Taft-Hartley Act.

July 13

▲ Lead prices advanced ½¢ to 13½¢ a lb.

▲ Robert R. Nathan stated in a report that he prepared for the CIO Steelworkers that the companies can raise wages, lower prices and make money with production as low as 80 per cent of capacity.

▲ American Iron and Steel Institute announced that steel production in June was 6,501,332 tons or a drop of over 1,000,000 tons from May. Production was at the rate of 82.2 per cent of capacity. Production for the first six months of 1949 set a new first half record of 45,928,476 tons or 96.3 per cent of capacity.

▲ Phillip Murray called a strike against U. S. Steel, Bethlehem and Republic, effective midnight July 15th.

July 14

▲ Frederick B. Blackall, Jr., past president of the New England Council, announced that an integrated steel plant is economically feasible in New England with the use of Labrador-Quebec ores. He estimates that such ore can be delivered to the New England coast for the same price that Mesabi ore is delivered in Duluth.

▲ Three oil companies cut prices in the Texas Gulf area on low gravity crude oil by 10¢ a bbl.

▲ Lead prices went up ½¢ to 14¢ a lb.

▲ Reconstruction Finance Corporation approved a loan of $34,000,000 to the Lone Star Steel Corp. for finishing facilities for manufacturing electric welded pipe. The company must spend $22,000,000 in expanding manufacturing facilities prior to receiving the loan.

▲ C. B. Lang, president of the Dominion Steel and Coal Co., stated that steel production in Canada had caught up with the demand.

▲ The House of Representatives passed a bill which will legalize freight absorption which has been made in good faith. The bill

differs slightly from the Senate version and must be modified somewhat before going to the president.

July 15

▲ Benjamin F. Fairless, president of U. S. Steel Corp., told President Truman that they would agree to appearing before the fact-finding board. He stated, however, that they would not necessarily accept any recommendations which the board might make.

▲ The Census Bureau reported that Russia has withheld manganese and chrome shipments to the United States in May. This is the second consecutive month that this has been done.

July 16

▲ Phillip Murray told the steel workers to stay on the job and thus called off the proposed steel strike.

▲ According to Ward's automotive reports, 155,350 vehicles were produced last week for a new high record.

▲ The Bureau of Labor Statistics reported that construction on 100,000 non-farm homes was started in June.

July 17

▲ Ernest T. Weir, chairman of the board National Steel Corp., stated that steel production may drop to 65 per cent of capacity by the end of 1949.

July 18

▲ Carroll R. Daugherty, chairman of the Steel Fact-finding board announced that it would convene in Washington today.

▲ The F. W. Dodge Corp. reported that the volume of contracts for building and engineering east of the Rocky Mountains was $4,467,000,000 in the first half of 1949 or 6 per cent below one year ago.

▲ Based on reports of companies having 94 per cent of capacity of the industry, the operating rate of the steel industry is scheduled at 78.3 per cent of capacity for the week beginning July 18th, 1949. This is equivalent to 1,443,500 tons of steel ingots and castings compared with 1,434,300 tons one week ago.

July 19

▲ Zinc prices went up ½¢ to 9½¢ per lb at East St. Louis.

▲ The Esso Standard Oil Co. raised heavy fuel prices from $1.20 to $1.35 a bbl in the Gulf of Mexico locations.

July 20

▲ The Lake Superior Iron Ore Association announced that ore consumption in June was 6,248,535 gross tons or 1,028,184 tons below May. Stocks are slightly higher than one year ago.

▲ Department of Commerce removed quantity limitations on tin plate and terneplate exports effective October 1st.

July 21

▲ The House adopted a bill which will extend indefinitely the present 90 per cent of parity price supports on basic crops.

July 22

▲ The Export-Import Bank is giving active consideration to a request for a loan of an additional $17,000,000 to the new steel plant in Brazil, which will be used to expand capacity from 250,000 to 375,000 tons of steel per year.

July 23

▲ Federal Security Agency announced that jobless benefits in June were $154,696,000 for the highest monthly total on record.

▲ Bureau of Labor Statistics announced that living costs went up 0.2 per cent between the middle of May and the middle of June.

July 24

▲ United Steelworkers of America estimate that their proposed pension would cost 10.9¢ an hour.

July 25

▲ Federal Reserve Board announced that non-durable goods production leveled off in June after a sharp decline.

▲ Zinc prices went up at East St. Louis another ½¢ a lb to 10¢ a lb.

▲ According to Securities and Exchange Commission, capital outlays for new plants and new machinery are expected to exceed $4,600,000,000 for the third quarter of this year.

▲ John E. Goble, president of National Tube Co., announced that a new electric steel pipe mill will be constructed at the National Works which will provide an annual capacity of 100,000 net tons of large diameter pipe.

▲ Based on reports of companies having 94 per cent of capacity of the industry, the operating rate of the industry is scheduled at 81.5 per cent of capacity for the week beginning July 25, 1949. This is equivalent to 1,502,500 tons of steel ingots and castings compared with 1,443,500 tons one week ago.

▲ F. W. Dodge Corporation reported that contracts awarded for building and engineering works in Pennsylvania during the first six months of 1949 were $334,052,000 or a decline of 12 per cent from the corresponding period of 1948.

July 26

▲ American Institute of Steel Construction reports that total bookings of fabricated steel in June were 93,053 tons. June shipments were 163,549 tons. Bookings for the first six months were 697,091 tons, 27.5 per cent less than 1948, and shipments for the first six months were 998,366 tons or 3.3 per cent higher than 1948. Backlog is now 583,289 tons.

▲ U. S. Steel Corp. reported that income for the second quarter of 1949 is $44,123,595 compared with $49,929,670 for the first quarter. Income for the first six months of 1949 was $94,052,265 compared with $53,443,018 in 1948.

July 27

▲ The Armco Steel Corp. announced that they have authorized immediate construction of a new $12,000,000 steel making plant which can produce 400,000 tons of steel ingots per year.

▲ General Motor Sales for the second quarter of 1949 were $1,595,000,000 for the largest in history.

▲ Lead prices went up ½¢ a lb for the second time this week for a new figure of 14½¢ a lb.

July 28

▲ Phillip Murray asked for a raise which will total 30¢ an hour broken down into wage increase 12.5¢, pension 11.3¢ and social insurance 6.27¢.

▲ The Bethlehem Steel Co. reported record shipments and earnings for the second quarter and also the first six months of 1949. Net profits for the first half of 1949 were $5.91 a share.

July 29

▲ Installment credit in June rose $243,000,000 to a record high of $9,133,000,000. The biggest increase was in automobile credit.

▲ The Allegheny Ludlum Steel Corp. is reopening two open hearth furnaces which were closed down last spring at Brackenridge, Pa. The second new 70-ton electric furnace also went into operation.

July 30

▲ Crucible Steel Co. restored two open hearth furnaces to production thus returning to full operations at its Midland, Pa. plant.

▲ The Sharon Steel Corp. put two of its blast furnaces back into production and the Shenango Corp. placed one of its furnaces in blast.

▲ United States Steel Corp. authorized construction of five sintering plants which will be able to handle 1,800,000 net tons of ore a year.

▲ H. G. Hilton, president of Steel Co. of Canada, stated that production in the first six months of 1949 was at capacity, and production and sales set new records.

July 31

▲ Reports from sixteen ingot producers show that with one exception, earnings in the second quarter were less than those in the first quarter of 1949 although much greater than in the same period of 1948.

▲ The Bethlehem Pacific Construction Steel Corp. has put in a new 10 in. double strand, high speed, rod and merchant bar mill.

MAINTENANCE CUT

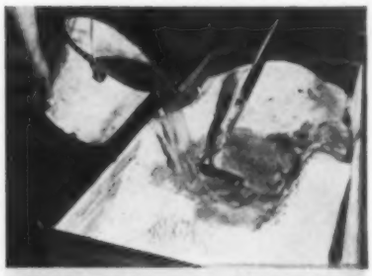
Several Thousand Dollars Per Year with **KAOCAST**

Photographs courtesy Ford Motor Company

A large automobile manufacturing firm found that high temperatures and severe operating conditions were playing havoc with the doors of their 15-ton electric furnaces. Run 16 hours a day, 5 days a week, these furnaces are poured every 2½ hours and are charged twice during each cycle. With a good grade of firebrick, furnace door linings lasted an average of only two or three days before replacements were necessary.

A trial installation of KAOCAST—the B&W high temperature Refractory Castable—was made. The KAOCAST doors stood up two to three weeks . . . *five to eight times longer than firebrick.* As a result, doors on all electric furnaces of this type are now lined with KAOCAST. *Savings in maintenance are running into thousands of dollars per year.*

Your B&W Refractories Engineer will be glad to show how KAOCAST will cut your furnace operating cost. Write or call him today.



KAOCAST, easy to use as ordinary concrete, can be mixed in mortar box or concrete mixer.

Shell of furnace door, cleaned, ready for installation of KAOCAST.

Shoveling KAOCAST into place. KAOCAST can also be poured like ordinary concrete, plastered in place, or applied with a cement gun.

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R-339

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Uniform lifting capacity is one of the reasons why more mills are standardizing on Ohio. Satisfy yourself. Send your next order to Ohio—*25 years a leader in magnetic materials handling.*

This magnet lifts big loads all day long!

OHIO PROTECTO-WELD MAGNET is welded *on top*, where weld cannot be dented in. Sizes include 39, 46, 55 and 65-inch diameters. Ohio also builds magnet control equipment.

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A-2027

Industry News...

SYNTHETIC PALM OIL SUBSTITUTE DEVELOPED FOR HOT DIP TINPLATE

▲ Research scientists at Armour Research Foundation of Illinois Institute of Technology are achieving successful laboratory results expected to have wide economic importance to the steel industry.

William R. Johnson, research, metallurgist; Layton C. Kinney, supervisor of chemical engineering, and John M. Parks, supervisor of nonferrous metallurgy, have developed a synthetic substitute for African and East Indian palm oil, a vital necessity in making hot dip tinplate. Mill tests will soon be run.

There is no domestic source of this palm oil, and, up to now, no substitute in general use.

About 7500 tons of the oil are used annually in the United States in hot dip tinning. All of the oil must be imported from North Africa or the East Indies over long shipping lanes. Supplies were greatly curtailed during World War II because of the submarine menace to shipping lanes and might be entirely cut off in another emergency.

Cost also has been an important factor. Before the war the oil sold as low as 8 cents per lb. After the war it went as high as 40 cents.

Price, which has fluctuated without notice, plus transportation difficulties, brought about the investigation sponsored by the American Iron and Steel Institute.

To discover and develop a substitute for African palm oil, Foundation scientists were confronted with what appeared to be an almost impossible list of requirements. The oil, to function properly, must have these characteristics:

It should make smooth, bright tinplate; drain rapidly and freely; possess low volatility; have high flash and fire points; neither oxidize nor polymerize readily; clean readily from the sheet; have low viscosity to permit pouring or pumping readily; be non-toxic, odor-free and preferably edible; should not become rancid during storage; not interfere with lithographing, lacquering or soldering, and should retard atmospheric corrosion.

And the substitute had to be inexpensive and readily available, preferably from domestic sources.

After extensive basic research on tinning oil action, the Foundation scientists selected dimerized linoleic acid (dimer acid) as having the best possibilities. This is a fatty acid product only recently available in quantity. It is made from common vegetable oils by heating them under pressure in contact with steam.

A mill test on this material was encouraging, although the dimer acid tended to increase in viscosity. Subsequent work was devoted to a study of dimerized acid base materials. Two general lines of approach were followed:

1. Correction of undesirable viscosity characteristics by use of addition agents.

2. Examination of various esterified dimer acid products which are known to have satisfactory low temperature viscosity characteristics and which give good resistance to heat bodying.

ARMCO TO BUILD THREE 225-TON OPEN HEARTHS

▲ Immediate construction of a new $12,000,000 steel making plant which can produce 400,000 tons of steel ingots per year has been authorized by the board of directors of Armco Steel Corp., Charles R. Hook, chairman, announced recently. It will be built just south of Armco's big east works plant in Middletown, Ohio. When it starts operation it will provide employment for more than 500 addi-

NEW MACHINE SHOP TESTS CUTTING OILS

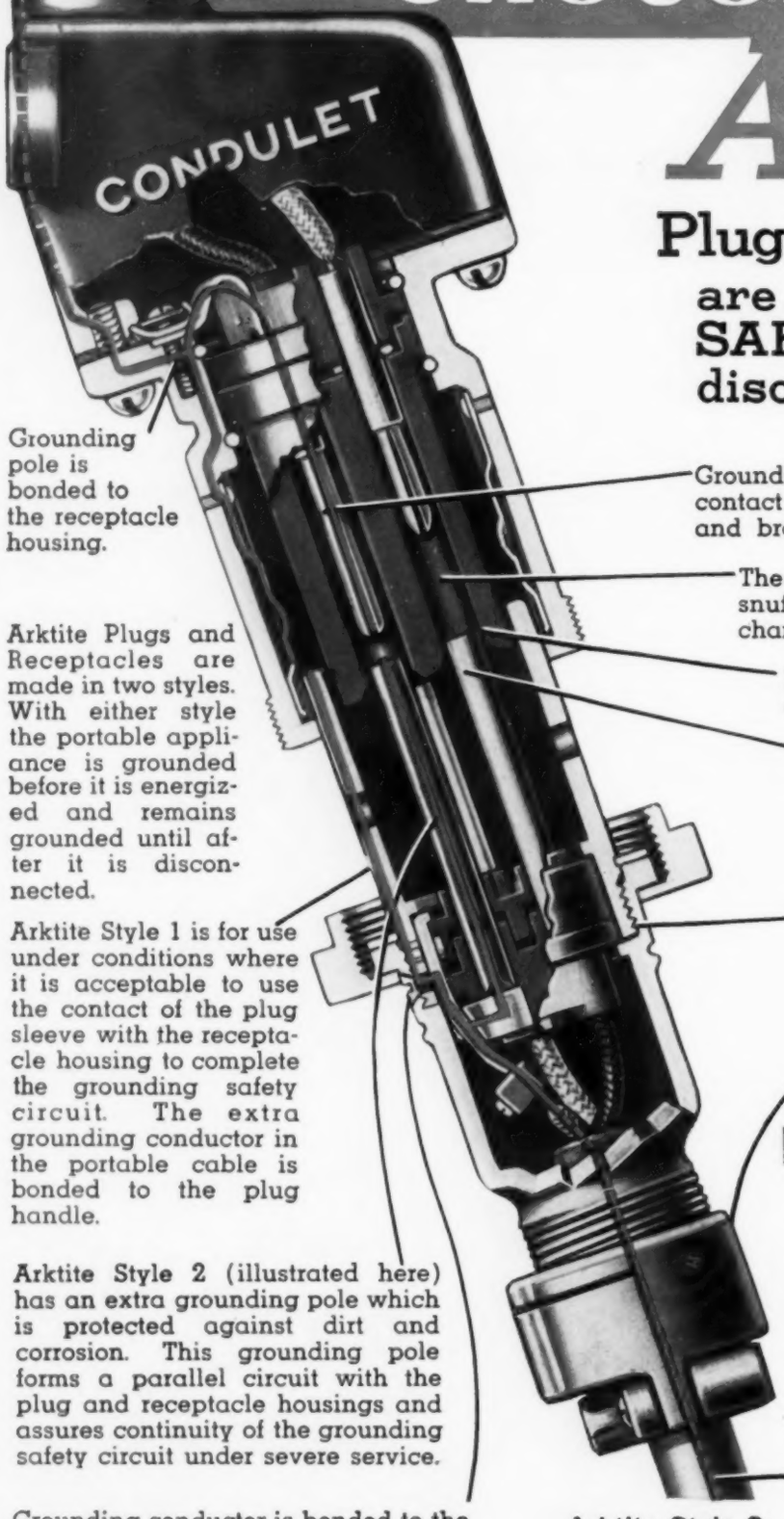
The new machine shop at the research laboratories of Gulf Oil Corp. has 18,479 sq ft of floor space. The main shop and assembly floor (below) occupy 10,676 sq ft, while storage space in the basement and mezzanine consume slightly more than 2500 sq ft. The new shop is planned to function as a tool for the oil firm's research and exploratory work. An important roll of the shop is that of testing cutting and grinding rolls. The laboratories are located at Harmarville, Pa.

CROUSE-HINDS

Arktite

Plugs and Receptacles

are circuit breaking and SAFE without additional disconnect equipment.



Grounding pole is bonded to the receptacle housing.

Arktite Plugs and Receptacles are made in two styles. With either style the portable appliance is grounded before it is energized and remains grounded until after it is disconnected.

Arktite Style 1 is for use under conditions where it is acceptable to use the contact of the plug sleeve with the receptacle housing to complete the grounding safety circuit. The extra grounding conductor in the portable cable is bonded to the plug handle.

Arktite Style 2 (illustrated here) has an extra grounding pole which is protected against dirt and corrosion. This grounding pole forms a parallel circuit with the plug and receptacle housings and assures continuity of the grounding safety circuit under severe service.

Grounding conductor is bonded to the plug handle.

Grounding pole is longer than the others so contact in the grounding circuit is made first and broken last.

The arc formed by pulling the plug is instantly snuffed in the confined insulated arcing chamber.

Each plug contact fits closely the opening of its individual arcing chamber.

The arc is broken while the plug contact is still a considerable distance inside of the arcing chamber. There is no danger of the arc traveling over to the other side of the circuit or to the housing.

Two-piece plug is easy to take apart and reassemble.

Direct-pressure clamp insures positive grip on the conductor cable.

Arktite Style 2. Sectional View

The green line indicates the grounding safety circuit.

CROUSE-HINDS offers the only complete line of circuit breaking plugs and receptacles—20 Amp. to 400 Amp., 250 volt D.C., 600 volt A.C.

Complete listings are in the Condulet Catalog.

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tional men. This is the largest single construction project to be started in the Miami Valley in several years.

This new steel plant will consist of three 225-ton open hearth furnaces of the latest design together with several miles of railroad tracks, pipe lines, high tension lines and other equipment necessary to operate the plant.

"Our engineering department has been working on plans for almost a year and these new open hearths are the first unit in what we hope will eventually be a much larger plant," Mr. Hook said. "Further expansion, however, will depend upon economic conditions in the future. We are proceeding with this major expansion at this time because there has been a constant growth in steel consumption in the area served by our Middletown plant. New companies using steel as their principal raw material have moved into this region, and existing companies have expanded. We hope that an adequate supply of steel will encourage continued growth in business and employment in this area."

Construction of the new Armco plant will be started immediately. In fact the work of leveling the site was begun several weeks ago. More than a half-million yards of slag must be moved before the work of building the plant foundations can proceed. It is estimated that the construction will require fifteen months.

Some idea of the size of the new Armco open hearth plant may be gained from the following facts:

The building which will house the open hearth furnace is 200 ft by 700 ft. It will have its own chemical laboratory, office and parking lot. Modern locker and shower rooms will be provided for the men.

Almost 5 miles of railroad track will be constructed, and about a mile and a half of truck roads.

Fifty thousand cu yd of earth must be excavated for building foundations.

Twelve thousand cu yd of concrete will be required in the foundations.

Seven thousand tons of structural steel will be needed to erect the main building, not including steel used in the furnaces.

The three big open hearth furnaces will require 10,000,000 gal of fuel oil per year to melt the steel.

BEARING MANUFACTURER EXPANDS FACILITIES

▲ Expansion of its plant at Shippensburg, Pa., to provide additional facilities for the production of antifriction bearing retainers was announced by SKF Industries, Inc.

The enlarged facilities will enable the ball and roller bearing firm to take over a substantial portion of work now subcontracted and to bring the bulk of retainer production under direct supervision.

This arrangement, which has been under consideration for some time, also will permit the company, in a period of declining business being experienced by industry generally, to maintain a more constant level of employment.

The Shippensburg plant, opened in September, 1947, and employing approximately 160 persons, now produces about 65 per cent of the company's retainer needs. Present plans call for the central Pennsylvania plant to manufacture from 80 to 85 per cent of the retainers by the end of 1949.

Work is under way on two addi-

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A little "RODINE" in the pickling bath saves both acid and metal.

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tions to the plant. These are to provide larger quarters for tool and die and stamping operations and increased storage space for dies and raw materials.

ELECTRIC WELDED PIPE TO BE MADE AT McKEESPORT

▲ The National Tube Co. will begin construction immediately on a new mill in McKeesport, Pa., for producing electric welded steel pipe. Production of pipe at the United States Steel subsidiary is expected by March, 1950.

The new mill will have an annual capacity of 100,000 net tons of 26-in. diameter steel pipe and larger, according to John E. Goble, president of the company.

Mr. Goble said the new plant will enable National Tube to compete in a wider field—particularly in large size pipe for oil and gas production.

No estimate has been made yet as to the number of men expected to be employed at the mill.

Much of the housing for the new mill already is standing, and the main construction work ahead between now and next spring will be devoted to installing foundations for the machinery.

The new plant represents a return to the manufacture of large diameter electric pipe in the McKeesport producing area of the company.

During the war, the electric weld pipe mill there was dismantled and replaced by machinery to manufacture shells, bombs and rockets.

ARC FURNACES INCREASE BRACKENRIDGE CAPACITY

▲ The first two arc furnaces of Allegheny-Ludlum Steel Corp.'s new electric furnace plant at Brackenridge, Pa., have been completed, and work is in progress on two more furnaces, all supplied by Swindell-Dressler Corp. The new department is laid out according to modern design practice, and will offer many operating economies.

The two furnaces already completed are of top-charge design, with shells 18 ft in diameter. Each furnace is equipped with a 16,000 kva transformer and is rated at 70 tons capacity.

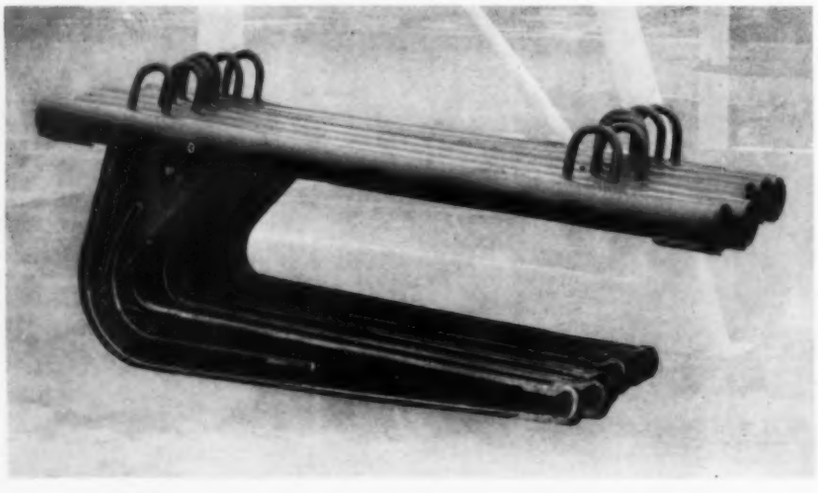
The third and fourth furnaces, now under construction, are also top-charge units of 60 ton capacity, with 17 ft diameter shells and 11,500 kva transformers. These furnaces were formerly installed in a government-owned facility, and have been rebuilt for the Brackenridge plant.

When completed, the new department will produce steel at a rate of more than 400,000 ingot tons annually.

BECKLEY COAL BED CAN BE USED FOR COKE

▲ Bituminous coal from West Virginia's Beckley bed, which covers more than 600 square miles in the State, can be used satisfactorily as a blending coal in making metallurgical coke, according to a Bureau of Mines technical report.

Reserves of the Beckley bed coal, largely low-volatile bituminous, are estimated at more than two billion tons, the report reveals, also pointing out that the Beckley coals can be used to augment better-known Pocahontas blending coals as reserves of



designed for **HEAVY-DUTY** service . . .

WELDCO Lightweight *Hairpin* Hooks

● These Weldco lightweight Monel pickling hooks are now in use in a New York wire mill, where they replaced bulky, old-style equipment. The hooks are 10′ 8″ long, and handle up to 3,000 pounds each; they're so corrosion-resistant that, although they are used constantly in hot 7½% sulphuric acid, they outlast heavy cast hooks 2 to 3 times.

Wire mills throughout the country prefer Weldco hairpin hooks because of their lightweight, toughness, corrosion-resistance, and long service life.

Why not find out what these economical, heavy-duty pickling hooks can do for your plant? Write, phone, or wire us today.

THE YOUNGSTOWN WELDING & ENGINEERING COMPANY

3703 OAKWOOD AVENUE YOUNGSTOWN 9, OHIO

the Pocahontas coals become depleted.

Although the Beckley coal is strongly expanding when carbonized alone, cokes made from blends of moderate proportions of Beckley and Pittsburgh coals were found to be equal in quality to similar blends of Pocahontas No. 3 and Pittsburgh bed coals.

In carbonizing tests, this coal yielded 80.6 per cent coke, and upon the basis of yield per ton of coal, 10,700 cu ft of gas, 6.2 gallons of tar, 1.63 gallons of light oil, and 19.4 lb of ammonium sulphate. With the exception of the coke yield, the recovery of other products was higher than the average yield from 11 other low-volatile coals previously tested by the Bureau.

Copies of Technical Paper 712, "Carbonizing Properties of Beckley-Bed Coal from Stanaford No. 1 mine, Mount Hope, Raleigh County, W. Va.," may be obtained from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C., for 15 cents each.

SHEET & TUBE BUILDING LARGER BLOOMING MILL

▲ Youngstown Sheet and Tube Co. wlil spend approximately $4,500,000 on its blooming mill at Campbell, Ohio, to roll wider slabs for heavier coils of sheets for the automobile industry.

In announcing the plans, President Frank Purnell said: "Our board of directors has authorized changes in the blooming mill at Campbell works to roll wider slabs for the purpose of making heavier coils of sheets to meet demands of the automobile industry.

"The present limit of slab width is 43½ in. while the new range will be up to 56 in. The installation means changes in the drives, tables, shears, manipulators and to numerous other facilities.

"It is not expected that capacity will be increased materially. The sole purpose is to keep the company in a competitive position. Cost will amount to approximately $4,500,000.

HEATER MANUFACTURER AWARDED LARGE ORDER

▲ Dravo Corp. here has been awarded one of the largest contracts for heating equipment received by the firm since the end of World War II, it was announced recently.

The order calls for 53 "Counterflo" heaters which will be used in a unique heating and ventilating system for a large automobile body manufacturing plant now under construction in West Mifflin Township near Pittsburgh.

The industrial heaters, manufactured at Dravo's Neville Island plant, will be installed in penthouses on the roof of the new plant. They are designed to blend fresh outside air with air recirculated from within the building. The mixture then will be warmed and distributed throughout the offices and plant for employee comfort.

U. S. STEEL TO CONSTRUCT FIVE SINTERING PLANTS

▲ Construction of five new plants to process powdery iron ore to usable size and to recover iron from blast furnace flue dust is to be undertaken soon at strategic centers by steel producing subsidiaries of United States Steel. Completion of the new facili-

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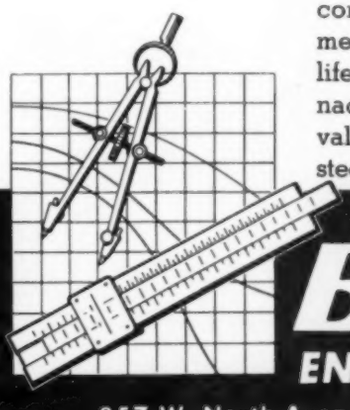
In this one compact cabinet..

ELECTRIC BRAINS that don't forget—
FINGERS that never tire

control all operations for the
FAST, AUTOMATIC REVERSAL
of open hearth furnaces!

Factory-wired, readily installed wherever convenient. Faster, smoother reversals mean greater production, longer checker life, greater fuel economy. Reverses furnace automatically on pre-set time intervals until changed. Compact, dust-proof steel cabinet.



BLOOM
ENGINEERING CO., INC.
857 W. North Avenue Pittsburgh 12, Pa.

ties will add some 1,800,000 net tons a year to the high grade iron ore available for United States Steel blast furnaces without requiring an equivalent increase in iron mining.

Large sintering plants of the most advanced design will be built at the Gary, Ind., and South Chicago, Ill., plants of Carnegie-Illinois Steel Corp., as well as at the Edgar Thomson and Carrie Furnace plants of that company in the Pittsburgh district. Another sintering plant will be installed at National works of National Tube Co. at McKeesport, Pa.

The new sintering plants will recover the substantial quantities of iron values present in flue dust and sludge recovered from the dust catchers and gas washers, respectively, which are essential parts of all modern blast furnaces. Flue dust has an iron content of approximately 50 per cent.

The new iron recovery program of United States Steel will conserve reserves of direct-shipping ores and provide blast furnaces in the Pittsburgh and Chicago districts with a charge of material of higher iron content than that of the ore as mined, and of superior physical properties. Completion of the new plants thus will conserve the high grade iron ore reserves of United States Steel and facilitate the use of a moderate proportion of lower grade ores without interfering with efficient and economical operation of the blast furnaces.

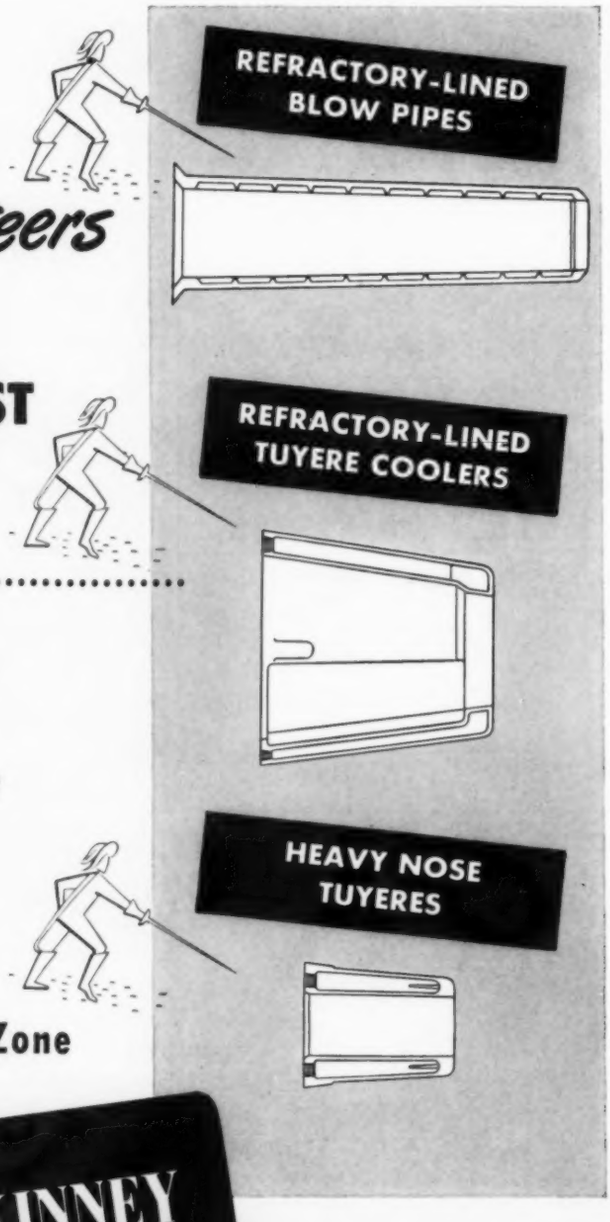
The importance of these facilities is apparent from the fact that over a period of ten years a metallics loss of approximately 3,000,000 tons can be traced to the presence of fines in iron ore. This loss, when translated into an equivalent amount of ore, equals approximately the ore requirement of one 900-ton blast furnace over that period.

Plants of United States Steel are already equipped with ten sintering plants to process flue dust recovered from blast furnace gas into "sinter," as the product is known in the steel industry. Production from these plants during 1948 was at a rate of about 3,400,000 tons of sinter per year. But more dust is recovered currently at steel plants than can be sintered by existing machines, resulting in accumulations of substantial quantities of flue dust.

The Three Musketeers

OF THE HOT BLAST SYSTEM

A protecting threesome for Hot Blast between Bustle Pipe and Combustion Zone



S. P. KINNEY Engineers, Inc.

233 Oliver Ave.
Pittsburgh 22, Pa.

DOCK IN OPERATION

Part of this huge new $18,500,000 facility, built jointly by the Baltimore and Ohio and New York Central Railroads, was operating last year. This spring, however, the completed dock began its first season of full-scale operation. The dock has three piers and extensive supporting yards. The two piers closest in the foreground contain three coal dumping machines, each one being capable of unloading 70-ton coal cars at the rate of one per minute. The pier in the background contains two ore machines, each with a 15-ton per minute capacity.

PITTSBURGH PIPE CLEANER COMPANY Offers A *Complete Service* in Solving Water and Sewage System Problems

If any phase of your pipe line operation is below peak performance, it may be solved by one of the following steps:

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The experience of thousands of successful pipe cleaning operations insures fast and competent service in any of the phases listed. Why not take advantage of this service in considering the solution of your pipe line problems.

Call the nearest Pittsburgh Pipe Cleaner Company engineer. He will be glad to discuss details of improving your pipe line operation and maintaining it at peak performance . . .

In line with our complete service policy, Pittsburgh Pipe Cleaner Company now features this additional service . . . expert application of the following plastic coatings to reduce pipe line corrosion: GACO-NEOPRENE, GACO-NEOFLEX, GACO-NITROCOTE, GACO-DURAFILM, and GACO-"316."
Write today for additional information.

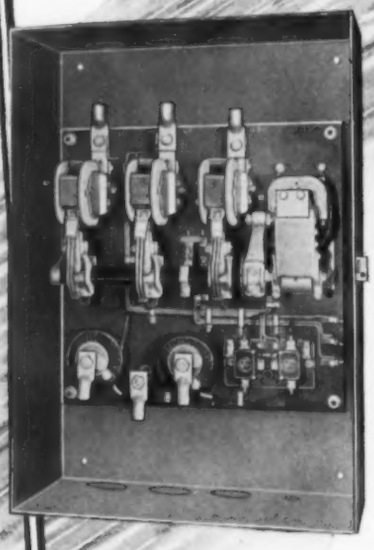
PITTSBURGH PIPE CLEANER COMPANY

133 Dahlem St., Pittsburgh 6, Pa.

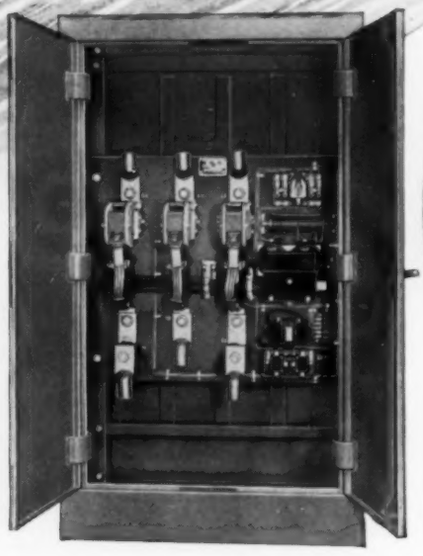
BALTIMORE • BIRMINGHAM • BOSTON • BRADENTON, FLORIDA • BUFFALO • CHARLOTTE • CHICAGO • CINCINNATI
DETROIT • HOUSTON • NEW YORK • PHILADELPHIA • ST. LOUIS • WASHINGTON

3 NEW CLARK STARTERS

FOR HEAVY DUTY MILL SERVICE



Bulletin 6013 — Size 5, 50 HP Across-the-line Starter.



Bulletin 6013 — Size 6 — 3 Pole, 250 HP, 550 V, 3 PH, 60 cycle Across-the-line Starter.

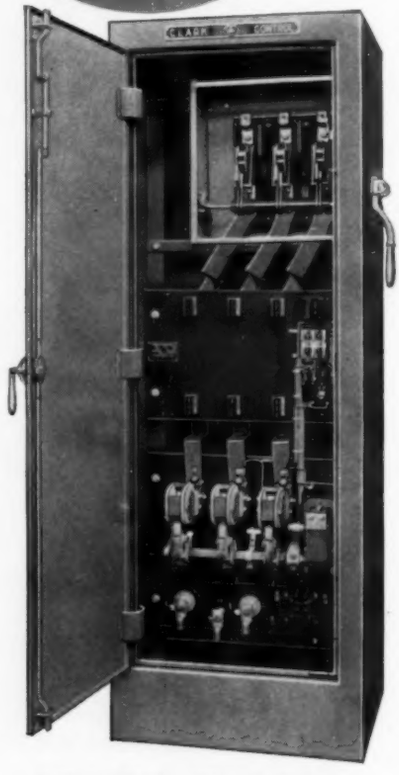
All three of these newly designed AC Across-the-line starters formerly used magnetic overload relays, which required factory pre-setting to special motor characteristics.

Sturdy CLARK Bulletin 7322 Overload Relays now replace magnetic overloads, and can be adapted in the field to various HP ratings by simply changing standard heaters. This change provides a new standard giving wide flexibility to applications.

"Do-nut" type current transformers mounted on load terminals are used to reduce current in the relay circuit.

Plenty of wiring space. Floor-mounted cabinets for Bulletin 6013 size 6, and Bulletin 6018 size 5. Note pan-type construction of doors for additional strength and rigidity and for close sealing.

Our nearest office or Agency will supply complete details.



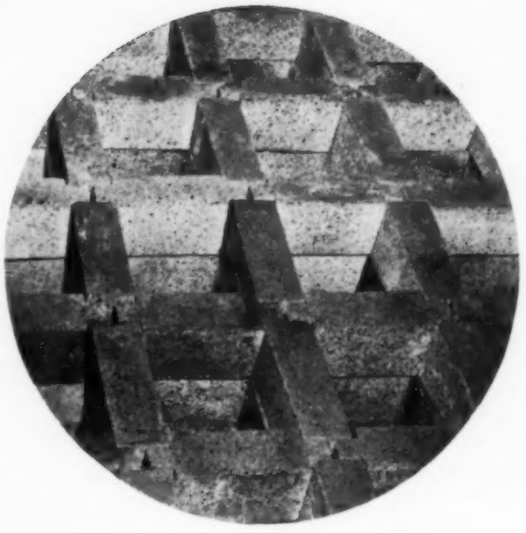
Bulletin 6018 — Size 5 AC Combination Starter. Non-reversing Magnetic Starter with Disconnect Switch—Fusible. (Fuses not shown.)

EVERYTHING UNDER CONTROL

THE CLARK CONTROLLER CO.

1146 EAST 152nd STREET, CLEVELAND 10, OHIO

WANT TO SAVE MONEY ON CHECKER WORK?



LET UNION SHOW YOU HOW

If you are using any size brick that carries a refractory extra to build solid flues, you are paying an added cost of as much as 60 per cent.

If you are using standard 9 in. brick, your checkers are not rigidly locked in place, and you are sacrificing valuable heating surface.

●

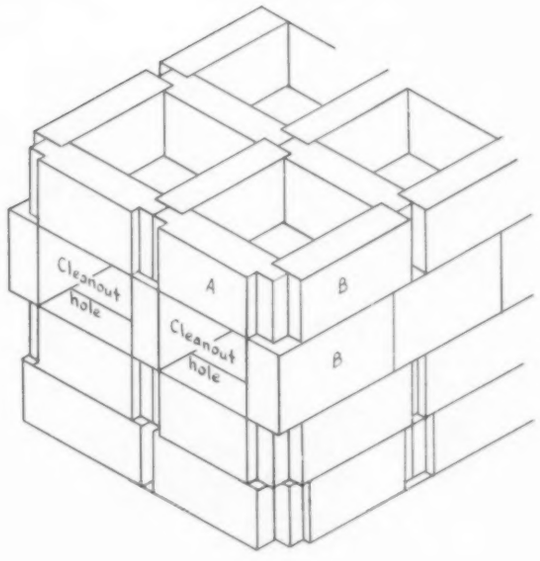
The Walters design gives solidly interlocked checkerwork at minimum cost. For 7¾ in. x 7¾ in. (or 7½ in. x 7½ in.) flues, two refractory shapes are used: a 9 in. x 4½ in. x 2½ in. (or 3 in.) standard brick (B) and the special brick (A) to go with it. This latter shape is the equivalent of a standard 9 in. brick and CARRIES NO EXTRA COST.

●

This design provides the popular solid chimney flue checkerwork, with its maximum heating surface. Where cleanout holes are desired, they may be formed by running a course of standard 9 in. brick through the setting at any desired point as shown at right.

Any flue sizes may be duplicated in the Walters design at a considerable saving in cost.

Walters checkerbrick is manufactured exclusively by UNION FIRE BRICK COMPANY in their new modern twin-tunnel kiln plant.



FOR COMPLETE INFORMATION, WRITE

UNION FIRE BRICK COMPANY

507 OLIVER BUILDING **PITTSBURGH, PA.**

FIRST FARREL® HD ROLL GRINDER IN CONTINUOUS USE SINCE 1923

No Case Known Of Any Machine Being Replaced By Another Make

Since 1923, when Farrel Heavy Duty Roll Grinders were first placed on the market, hundreds of these machines have been installed in steel and nonferrous rolling mills. One major steel company alone has twenty-two in continual, every-day use.

Farrel-Birmingham engineers explain the success of these machines by pointing out that *they provide for all five of the major essentials of modern-day roll finishing.*

1. HIGH PRODUCTION—Reports from users indicate that with the latest type machines they are able to cut roll grinding time substantially, and at the same time obtain rolls with a perfect surface free from marks of any kind.

2. FINE FINISH — Rolls can be ground to any desired finish which can be obtained with wheels at present available.

3. REDUCED LABOR AND ROLL COSTS —Faster grinding means less labor per roll. In addition, rolls have longer life because the exceptionally smooth and vibration-free action in roll, wheel and traverse drives means less metal has to be removed to clean up a roll in roughing and finishing operations. This reduces the frequency of roll replacement and, consequently, the investment in new rolls.

4. CONTINUOUS DEPENDABILITY— The best proof of the dependability of the Farrel Roll Grinder is found in the tendency of users of one machine to buy a second, third and more machines as their production requirements increase.

5. RANGE OF APPLICATIONS — The Farrel Roll Grinder finishes all types of rolls (chilled iron, alloy iron, steel, brass, rubber, granite, etc.) used in the rolling of any sheet materials, as well as other cylindrical parts requiring accuracy within close limits.

Write for a free copy of Bulletin No. 115 which shows why this machine is able to provide this unique 'five-point performance.'

FARREL-BIRMINGHAM COMPANY, INC., ANSONIA, CONNECTICUT

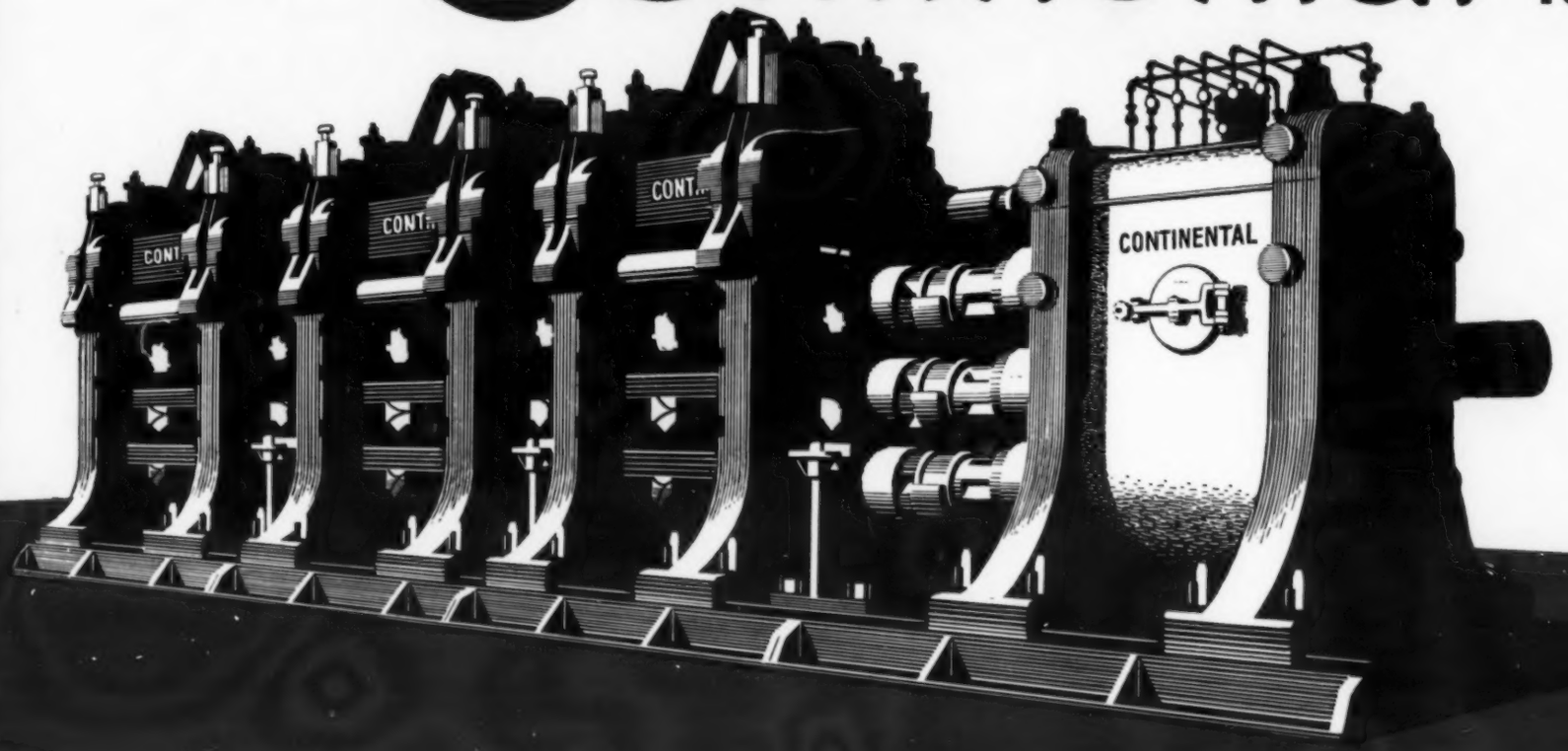
Plants: Ansonia and Derby, Conn., Buffalo, N. Y.
Sales Offices: Ansonia, Buffalo, New York, Pittsburgh, Akron, Los Angeles, Houston

Farrel-Birmingham®

FB-553

Continental

for STRUCTURAL and BAR MILLS



Designed and built by Continental with full complement of auxiliary mill equipment.

Continental

Continental FOUNDRY & MACHINE CO.

CHICAGO . PITTSBURGH

Plants at: E. Chicago, Ind.; Wheeling, W. Va.; Pittsburgh, Pa.

Rolling Mills and Equipment
Iron and Steel Rolls
Carbon and Alloy Steel Castings

Accurate Records with

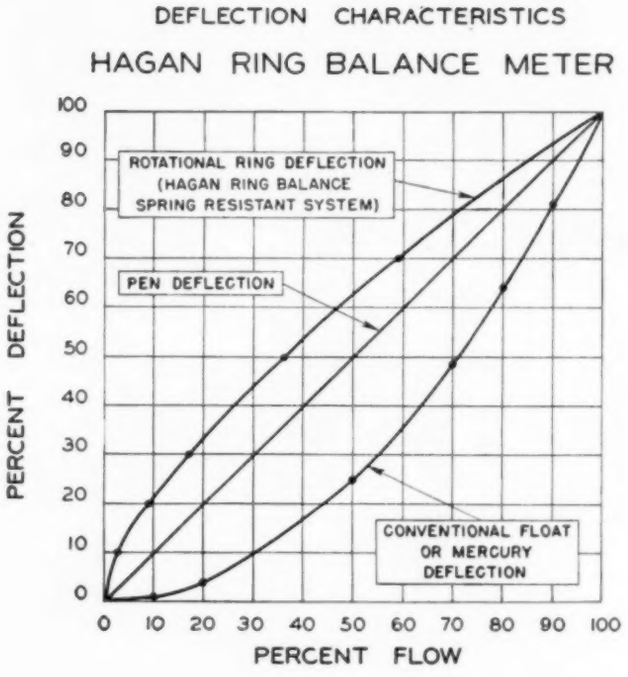
Hagan Ring Balance Flow Meters

Hagan Ring Balance Flow Meters give you an accurate record of gas and air flow to soaking pits and heating furnaces at all times.

Good low-flow response is inherent in the design of the Hagan Ring Balance meter. The ring, pivoted on a knife-edge bearing, moves in response to extremely low differentials, and this ring movement is proportionately *greater* at low flows than at high.

Since flow is a square root function of differential pressure, all orifice type meters require correction of the movement of the primary element in order to produce a linear chart. In conventional meters, this correction is a *multiplication* of the primary movement, and hence a multiplication of any error. In Hagan Ring Balance meters, however, the correction is a *reduction* of the primary movement, and this reduction is greatest at the lower end of the scale.

For full information on this and other features of Hagan Ring Balance meters—including Dual meters which record both gas flow and air flow on a single chart—write to Hagan Corporation, Hagan Building, Pittsburgh 30, Pa.



Graph shows how compensating mechanism of Ring Balance meters reduces movement of pressure responsive element, while in conventional meters, this must be magnified to produce a linear flow chart.

HAGAN HALL BUROMIN CALGON

HAGAN CORPORATION

RING BALANCE FLOW AND PRESSURE INSTRUMENTS
THRUSTORQ FORCE MEASURING DEVICES
BOILER COMBUSTION CONTROL SYSTEMS
METALLURGICAL FURNACE CONTROL SYSTEMS

Hagan Corporation
Ring Balance Meter Division
Hagan Building, Pittsburgh 30, Pa.

Please send me further information on Hagan Ring Balance Flow Meters. I am particularly interested in.....

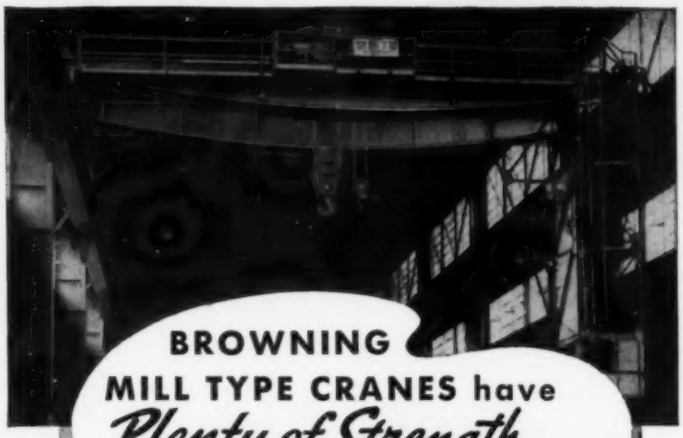
NAME.....

COMPANY.....

STREET.....

CITY..... STATE.....

ISE-8



BROWNING
MILL TYPE CRANES have
Plenty of Strength WHERE
STRENGTH IS NEEDED!

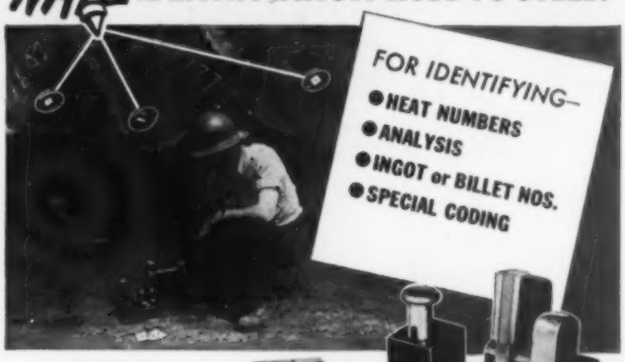
Browning Mill Type Cranes are built in accordance with A. I. S. E. specifications. They incorporate the types of motors and controls on which your mill or industry has standardized. This flexibility adapts your VRB crane *perfectly* to your needs. Only the finest materials are employed. Browning heavy duty cranes meet the most rigid demands and satisfy the most critical users. Our design, placing plenty of strength wherever needed, is the outgrowth of 48 years' experience in the crane industry.

"Built as you yourself would build them"

Write for our Bulletin "S".

VICTOR R. BROWNING & COMPANY, Inc.
BOX 309, WILLOUGHBY (CLEVELAND), OHIO
Designers and Builders of Electric Overhead Traveling Cranes and Hoists and Electric Revolving Cranes

NAIL IDENTIFICATION TAGS TO STEEL!



—with the
"SAFETY" TAG EMBOSSING and TAGGING OUTFIT

It's hard to believe, but it's true—this Outfit enables you to quickly nail metal identification tags to hot or cold steel ingots, billets, slabs, etc. Tags are embossed, pierced and nailed to steel by swinging hammer in the ordinary manner. Send for complete data today on this remarkable unit.

Write for Bulletin J-547

M.E. CUNNINGHAM CO.
SAFETY STEEL STAMPS
105 East Carson Street • Pittsburgh 19, Pa.

The biggest THIEF in America

All through the summer—through hot, humid days and hot, humid nights—the biggest thief in America will be raiding your plant. Wherever steel is handled—where it is stamped and milled or machined or ground, where it is pickled or cleaned or assembled—RUST will be busy, robbing you of production, robbing you of profit.

But you don't have to put up with this moist-month thievery. The Oakite Technical Service Representative in your vicinity is well equipped with materials and methods for fighting RUST. Phone him today for expert help in arresting RUST in every part of your plant.

FREE There is no charge for Oakite advisory service on any problem of metal cleaning. Write to Oakite Products, Inc., 19 Thames St., New York.

OAKITE 1909 1949 40th ANNIVERSARY YEAR

OAKITE
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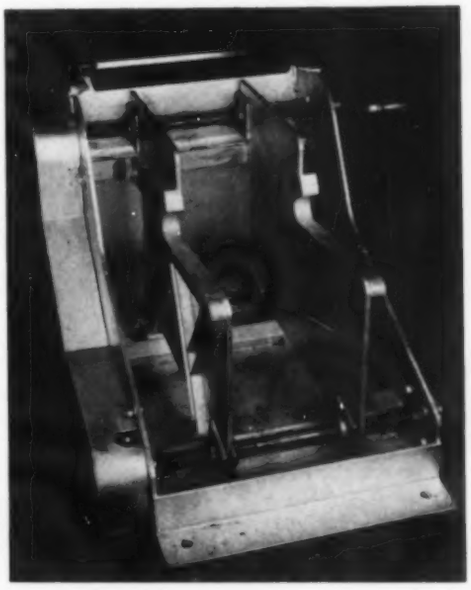
INDUSTRIAL CLEANING MATERIALS • METHODS • SERVICE

Technical Service Representatives Located in Principal Cities of United States and Canada

ROCKWELL COIL BOXES



for Coils of Strip to 3000 lbs.

Rockwell also builds batch and continuous furnaces, coiling machines, strip stitchers, pickling tanks and machines, dryers, ovens and special equipment.

ROCKWELL SINCE 1888 BUILT

W. S. ROCKWELL CO.
FURNACES · OVENS · MACHINERY
244 Eliot Street • Fairfield, Conn.
In Canada: Francis Hankin & Co., Ltd. Montreal & Toronto

"That 100-foot pipe run is shot again, chief... the darn thing corrodes through every six months!"
PLANT MANAGER
"Let's try 'KARBATE' pipe this time"

● *Are there spots like this* in *your* plant? Is corrosion causing repeated replacements of pipe line? If so, here's what "Karbate" Impervious Graphite Pipe can offer:

1. Resists the action of acids, alkalis and other chemicals
2. Light weight with adequate strength
3. Resistant to mechanical shock
4. Immune to thermal shock
5. Easy to machine and install
6. Full range of sizes and fittings immediately available

Write for bulletins M-8800 B and M-8801A. Learn about ease of **ordering** and **installing** "Karbate" Impervious Graphite Pipe and Fittings. Write Dept. IS

The term "Karbate" is a registered trade-mark of

NATIONAL CARBON COMPANY, INC.

Unit of Union Carbide and Carbon Corporation

UCC

30 East 42nd Street, New York 17, N.Y.

Division Sales Offices:
Atlanta, Chicago, Dallas, Kansas City, New York, Pittsburgh, San Francisco

Foreign Department: New York, U. S. A.

These products sold in Canada by Canadian National Carbon Co., Ltd., Toronto 4, Canada

Personnel News...

O. L. Pringle has been elected vice president in charge of sales and **Laurence S. Dahl** has been elected vice president in charge of operations of Columbia Steel Co. At the time of his election, Mr. Dahl was general superintendent of the Youngstown, Ohio, district operations of Carnegie-Illinois Steel Corp. Succeeding Mr. Dahl is **John W. Humphrey,** who has been assistant general superintendent in the Youngstown district.

L. J. Westhaver, general superintendent of the American Steel & Wire Co.'s Donora, Pa., steel and wire works, has been named Duluth, Minn., district manager of operations for the wire company. **B. E. Pheneger,** present Duluth district manager, has been appointed assistant to the vice president of operations and will make his headquarters in Cleveland, Ohio. **Harold Cope,** general superintendent of the American Steel & Wire Co.'s central furnaces and coke works, has been named Donora steel and wire plant superintendent, replacing Mr. Westhaver. **Harry O. Johnson,** superintendent of the Donora blast furnaces, succeeds Mr. Cope as central furnaces and coke works general superintendent. **Jacob W. Cox,** assistant to superintendent of the coke works in Cleveland, replaces Mr. Johnson as Donora blast furnace superintendent.

Otto J. Leone has been appointed manager of industrial sales for Trion, Inc., Pittsburgh, Pa. Mr. Leone is a registered professional engineer in Pennsylvania, having received his bachelor of science degree in mechanical engineering at Carnegie Institute of Technology. He has been with Carnegie-Illinois Steel Corp., Bristol Co., and John D. Hiles Co.

Donald E. Whitehead has been appointed lubrication engineer, Crucible Steel Co. of America, with headquarters at Pittsburgh. He formerly was employed by Carnegie-Illinois Steel Corp. in the same capacity.

Samuel H. Reynolds has been appointed sales manager of Great Lakes Carbon Corp.'s electrode division. Mr. Reynolds succeeds **George O. O'Hara** who resigned from the corporation to establish his own sales agency in California where he will represent the electrode division as well as other manufacturers. Before coming to Great Lakes Mr. Reynolds had been with Crucible Steel Co. of America for 24 years, since 1941 as manager of stainless steel sales.

William H. Compton, who has served as manager of the Rockford, Ill., sales office of Reliance Electric & Engineering Co. for the past four years, has been made supervisor of standard motor sales with headquarters in the company's general offices in Cleveland, Ohio.

William S. Lowe was elected to fill the position of executive vice president of A. P. Green Fire Brick Co., St. Louis, Mo.

Frank B. Nimmo has been elected president of the Fretz-Moon Tube Co., Inc., Butler, Pa., succeeding Dana Fox, who died May 9. Prior to election, Mr. Nimmo was executive vice president and treasurer of the Lumsden and Van Stone Co., Boston, Mass.

Arthur F. Wirtz, Jr. and **George L. Wirtz, Jr.,** have joined Atlas Mineral Products Co., being assigned to supervision and sales departments respectively, at Mertztown, Pa.

William Van C. Brandt retired on June 30 from his service with Electric Storage Battery Co., Philadelphia, Pa. He was manager of the Exide railway and motive power battery sales division. Mr. Brandt has represented Electric Storage Battery Co. in the Electric Industrial Truck Association for the past 25 years, and has been appointed managing director of that association.

R. L. Brown has recently been appointed by Westinghouse as division engineer in charge of engineering and development of instrument transformers, tap changers, and large power centers for its transformer division in Sharon, Pa. He succeeds **J. H. Chiles, Jr.** who has been made engineering manager for the entire transformer division.

F. E. Schuchman has been elected president of Homestead Valve Manufacturing Co., Coraopolis, Pa. **W. R. Schuchman,** was named chairman of the board after 28 years as president, and **J. E. Roth,** former board chairman, was named chairman of the advisory committee. Other officers named were **Bradley McCor-**

LAURENCE S. DAHL

B. E. PHENEGER

HAROLD COPE

HARRY O. JOHNSON

FOR HARD FACING AND REPAIR

Amsco

WELDING PRODUCTS

Amsco NICKEL-MANGANESE

Amsco Nickel-Manganese filler bars and electrodes built up this dipper used in the rugged service of a northern iron ore mine. For buildup and repair work on manganese steel, Amsco Nickel-Manganese will provide a long-wearing surface to resist heavy impact and abrasion. Nickel-Manganese electrodes are cold drawn rods, provided either coated for D.C. and A.C. or bare for D.C. welding. Weld deposits surface harden to 450-550 Brinell under cold working and have a toughness and ductility which approaches that of standard 13% manganese steel. Drilling sheaves, spindles, crossings, wobblers, crushers, and hammer mills are other applications where Nickel-Manganese has proved its value. Amsco cast and rolled repointer bars, plates, and hardfacing rods are also available. Write for Bulletin 10-A and W-1 for sizes and types of bars.

Ask for new booklet: "The Metallurgical Background for Welding Manganese Steel"

AMERICAN Brake Shoe COMPANY — AMERICAN MANGANESE STEEL DIVISION

Foundries at Chicago Heights, Ill., New Castle, Del., Denver, Colo., Oakland, Calif., Los Angeles, Calif., St. Louis, Mo.
Offices in principal cities. Made and sold in Canada by Canadian Ramapo Division of Joliette Steel Ltd., Niagara Falls, Ont.

mick, secretary, and **N. E. Kolesar,** assistant treasurer.

Everett C. Girty was appointed superintendent of the National Roll & Foundry Co. plant at Avonmore, Pa. Mr. Girty was associated with the Pittsburgh Rolls division of Blaw-Knox, in the capacity of metallurgist, production development engineer and superintendent.

Paul E. Thomas, who has been chief engineer, was named assistant to general superintendent of Carnegie-Illinois Steel Corp., Gary, Ind. **Daniel E. Wise**

PAUL E. THOMAS

will succeed Mr. Thomas as chief engineer. Mr. Wise has been serving as chief engineer of the Clairton, Pa. works of Carnegie-Illinois.

George F. Ritenbaugh, who rose from office boy to secretary-treasurer of Heppenstall Co., retired after 40 years' service with the Pittsburgh firm. He is retiring due to ill health. Mr. Ritenbaugh joined Heppenstall at the age of 15. He was the second oldest employee in terms of service.

John J. Radigan was appointed director of industrial relations of E. W. Bliss Co., Toledo, Ohio. Mr. Radigan has been associated with Bliss since 1946 and was previously assistant director of personnel of all plants.

Prior to his two years' service in the U. S. Navy during World War II, he was employed in labor relations work at the Delco Division of General Motors in Bloomfield, New Jersey. He received his education at Paterson State Teachers College and the John Marshall School of Law.

Edison Sickman has been appointed district sales manager of the Middle Atlantic territory of Atlas Mineral Products Co.

George P. Gabriel, who recently received a degree in chemical engineering at Penn State College, has accepted a position as engineer with Atlas Mineral Products Co. at Mertztown, Pa.

Two promotions in the purchasing department of Republic Steel Corp. were announced today by **Frank J. Laskey,** manager of purchasing and raw materials.

J. H. Graebing, formerly purchasing agent in charge of the mill supply division of Republic Steel Corp., Cleveland, Ohio, has been promoted to purchasing agent for alloys and refractories. In this position he succeeds the late **Ralph Bowman** who had held that

position for many years. Mr. Graebing will be succeeded by **J. W. Lowry** who has been a buyer in the mill supplies division.

Frank L. Snyder, whose entire business career has been with the Westinghouse Electric Corp., has been appointed manager of the firm's transformer division in Sharon, Pa. He succeeds **John K. Hodnette,** vice president, who recently became general manager of industrial products with headquarters in Pittsburgh. Succeeding Mr. Snyder as transformer division engineering manager is **John H. Chiles, Jr.,** who joined the company in 1925.

John N. Marshall was elected chairman of the board and chairman of the executive committee of Granite City Steel Co.; **Nathaniel B. Randolph** was elected

NATHANIEL B. RANDOLPH

president; **George B. Schierberg** was elected vice president, and **J. P. Erwin Niedringhaus** was elected a member of the board of directors.

William J. Tunny has been appointed superintendent of electrical maintenance at the Indiana Harbor, Ind., plants of Youngstown Sheet and Tube Co.

Mr. Tunny joined the company 30 years ago, working as tracer in the engineering department, motor inspector, wireman, electric shop work, electric testing engineer, chief electric testing engineer and assistant electrical engineer for several years.

C. H. Bartlett was appointed sales manager for the transformer division of Westinghouse Electric Corp. at Sharon, Pa. Mr. Bartlett succeeds **W. W. Sproul** who has just been named sales manager of industrial products for the entire company.

Dr. C. R. Payne was named president of Electro-Chemical Supply and Engineering Co. of Paoli, Pa. Other officers are **J. Wm. Grant** vice president and sales manager, **William A. Sesher,** treasurer and production manager, and **Walter L. Sheppard, Jr.,** export sales manager.

William G. Findlay, former manager of the Joseph T. Ryerson & Son, Inc. plant in Pittsburgh, Pa., has been transferred to Chicago, Ill., as manager of the work order division in charge of work order sales for the entire nation-wide group of thirteen Ryerson steel-service plants. **A. L. Petersen,** former manager of the company's plant in St. Louis, Mo., has been transferred to Pittsburgh, Pa., succeeding Mr. Findlay as manager. **John M. Acee,** former manager of sales at the Ryerson

high ratios ?

ONE OF 93

DE LAVAL
DOUBLE REDUCTION WORM GEARS

De Laval double reduction speed reducers, consisting of combinations of double worm gear reductions, or helical and worm gear reductions, are available with overall ratios up to approximately 8000 to 1. De Laval single reduction worm gear speed reducers are available in ratios up to 90 to 1. If high ratios are your requirement, worm gear speed reducers are the answer—particularly if space is limited and reliability is important. A De Laval representative will help you pick the right size and type.

This double reduction De Laval Worm Gear Speed Reducer is available in many standard ratio combinations, with horizontal or vertical output shafts and is but one of 93 sizes and types of standard De Laval Worm Gear Speed Reducers.

Send for Catalog 05-14-R

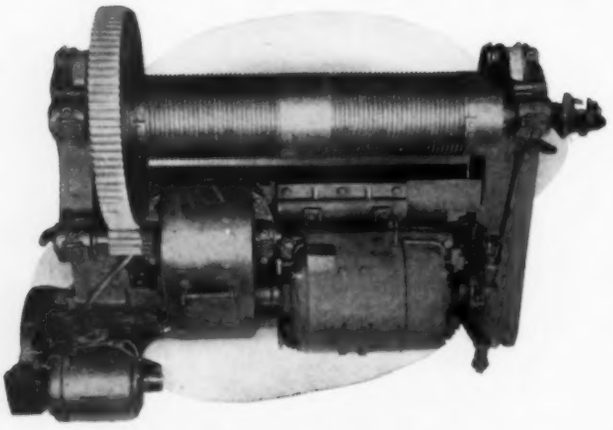
DE LAVAL

Worm Gear Division: De Laval Steam Turbine Co., Trenton 2, N. J.

TURBINES • HELICAL GEARS • WORM GEAR SPEED REDUCERS • CENTRIFUGAL PUMPS
CENTRIFUGAL BLOWERS AND COMPRESSORS • IMO OIL PUMPS

STOP....

OIL SHOWERS FROM CRANE MOTORS



WITH NON-FLUID OIL

TRADE MARK REGISTERED

Why put up with this visible evidence of high lubrication and application costs? Besides NON-FLUID OIL saves further time and money because its dripless qualities cut down stock cleaning costs.

See for yourself how NON-FLUID OIL gives cleaner lubrication and spotless products . . . economically. Write today for instructive bulletin and free, testing sample of NON-FLUID OIL.

NEW YORK & NEW JERSEY LUBRICANT CO.

292 MADISON AVENUE, NEW YORK 17, N. Y.

WORKS: Newark, N. J.

WAREHOUSES:

Charlotte, N. C. - Greenville, S. C. - Atlanta, Ga.
Providence, R. I. - Detroit, Mich. - Chicago, Ill.
St. Louis, Mo.

NON-FLUID OIL is not the name of a general class of lubricants but is a specific product of our manufacture.

plant in St. Louis, Mo., has been named manager of that plant, succeeding Mr. Petersen.

A. J. Rinnander, formerly with the Chicago Pneumatic Tool Co., New York, N. Y., has become a member of Harnischfeger Corp., Milwaukee, Wisc. Mr. Rinnander will supervise field activities on a national basis.

Obituaries

J. D. Berg, 66, chief executive officer and a director of Dravo Corp., Pittsburgh, died June 29, in his home in Chatham, Mass. Mr. Berg has headed Dravo Corp. since the death of its founders F. R. and R. M. Dravo in 1934. He served as board chairman from 1934 to 1946, at which time he was elected to his present position. Although Mr. Berg resided for the past two years in Chatham, Mass., he remained active in the affairs of Dravo Corp.

Hayward Niedringhaus, 58, president and general manager of the Granite City Steel Co., Granite City, Ill., died unexpectedly July 7 in Rockport, Mass. A member of the third generation in a family of steel manufacturers, Mr. Niedringhaus has served as president of the Granite City Steel Co. since 1929. The company was founded by his grandfather, William F. Niedringhaus, and is the largest steel mill in the St. Louis area.

At the age of 19, Hayward Niedringhaus started

We asked a few Operators how they are doing with

ANGLE FLOW TUYERES

U. S. Pat. 2,124,437

Tuyere at top-center of illustration is Angle Flow type with refractory nose.

Here's What They Reported . . .

Increased requests for the Angle Flow Tuyere, both with and without refractory nose, prompted us to check current results with angle flow installations. These operators enthusiastically reported greatly improved conditions, reduced burning after a switch to Angle Flow Tuyeres.

With tuyere pointed down (towards six o'clock) one operator reports his tuyere life increased from 24 days on conventional type to 100 days with refractory nose Angle Flow Tuyeres. Another who was getting from 30 to 35 days on a conventional type had had Angle Flow units with refractory nose in operation for 60 days and they still remained in the furnace. A third operator stated that he had been burning certain tuyeres nearly every day and that Angle Flow Tuyeres had apparently corrected this condition.

Other reports equally favored Angle Flow Tuyeres. There is every indication that this tuyere design, in Falcon quality casting, is capable of eliminating many troublesome, costly burning problems. Certainly they warrant a trial installation. Falcon is licensed to produce the Angle Flow Tuyere under U. S. Pat. No. 2,124,437 and is prepared to offer prompt delivery.

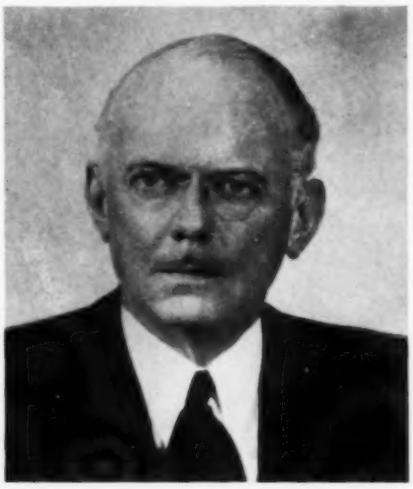
Telephone Collect 3-4186

FALCON BRONZE CO.

YOUNGSTOWN 3, OHIO

Established 1890 • Incorporated 1893

work as a laboratory assistant at the steel company. He was promoted to personnel director in 1916. In 1917, he enlisted in the Air Forces and served during World War I with the Sixth Air Squadron. He was discharged with the rank of sergeant. Returning to Granite City



HAYWARD NIEDRINGHAUS

Steel, he became works manager in 1920, managing director in 1924, and served as vice president and general manager from 1925 to 1928. He became president and general manager in 1929.

LOOK TO THE FUSE LEADER FOR PRODUCTION PROGRESS

Only 3 PARTS

To Handle In Renewing Link

WARE HI-LAG FUSE Construction establishes a top standard for rugged simplicity. There are only 3 PARTS to handle to replace blown link: — the Fibre Case — the Knife-Blade Assembly — the Closure Ring. Only 1 wrench needed to loosen nuts and slip out blown link. Assembly can be inserted either end in Case.

WARE FUSE CORPORATION
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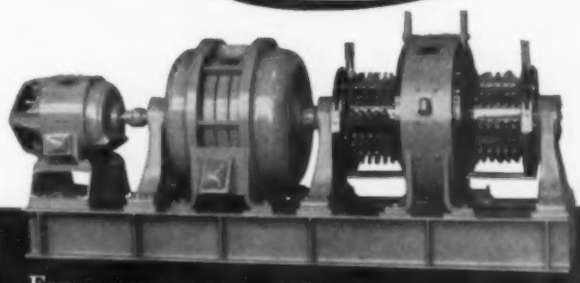
Motor Generators by COLUMBIA



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Electroplating — Anodizing
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There's a Columbia M-G Set available for your needs, whether you have a small plating bath or a large continuous strip plating line. Capacities up to 20,000 Amperes; 6 Volts and up. Dependable, performance proved, for many years. Your inquiries solicited.

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COLUMBIA ELECTRIC MFG. CO.
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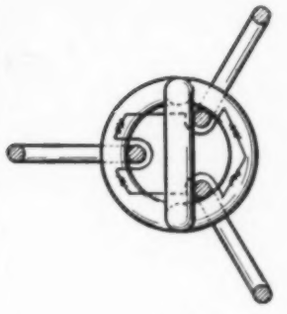
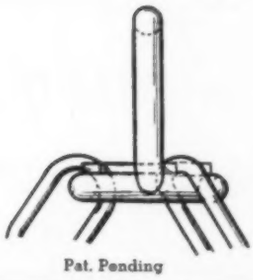
...LONG LASTING MAGNET CHAINS



Heat-treated high alloy steel PLUS the patented ring to eliminate rubbing and twisting gives Downtown Frictionless Magnet Suspension Chains up to 3 times the life of old-style suspension chains.

Locating Plate keeps magnet face level.

No more periodic annealing.



Pat. Pending

For these reasons Downtown Suspension Chains offer you best dollar value.

Each chain for 55 inch magnets is tested to 89,000 lbs. Each chain for 65 inch magnets is tested to 115,000 lbs. Don't delay! Write now for prices. Prompt shipment from stock.

DOWNTOWN Company
1836 EUCLID AVE. • CLEVELAND 15, OHIO

15-TON SCARFING BUILDING CRANE

BUILT BY MORGAN Engineering

Illustrated is a Morgan 15-ton, 3-motor, 40′-0″ Span Half Gantry Type Scarfing Building Crane. Hoist is actuated through a worm reduction unit for operating a counterweighted hoist rack connected to two lifting magnets, for handling slabs.

THE MORGAN ENGINEERING CO.

ALLIANCE, OHIO PITTSBURGH—1420 OLIVER BUILDING

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Equipment News...

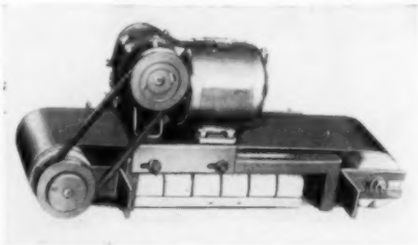
MAGNET UNIT ACHIEVES COMPLETELY AUTOMATIC SEPARATION OF MATERIALS

▲ Completely automatic separation of magnetic and non-magnetic materials with an Alnico plate magnet has been achieved with the self-cleaning "Perma-Plate" recently developed by Dings Magnetic Separator Co. This permanent non-electric magnet unit is designed to provide moderately priced automatic protection for crushers, grinders, pulverizers, stokers and other machinery susceptible to tramp iron damage; to remove contaminating iron from such materials as food, grain, liquids, sand, coal, fertilizer, rubber, chemicals, ceramics, plastics, etc.; and to prevent fires and explosions caused by tramp iron sparks in dust laden atmospheres. It can be installed over conveyor belts, spouts or chutes.

The unit consists of a heavy duty "Perma-Plate" magnet and a motor-driven, endless cross belt. The magnet's powerful force attracts and holds tramp iron to the underside of the cross belt, which carries it to the side beyond the influence of the magnetic field, at which point it is discharged. The Perma-Plate Magnet incorporated in the unit is made up of a series of powerful "C" shaped Alnico magnets, the poles of which are secured to steel plates, and the entire assembly is mounted on an aluminum face plate.

The advanced design allows uniform magnetic strength across the entire face of the magnet, with no "dead spots" for tramp iron to slip through. Pole plates project up from the magnet surface to provide the extra magnetic strength of powerful attracting edges. The self-cleaning Perma-Plate is equally effective with wet or dry materials and the magnet itself can be completely submerged. The manufacturer guarantees its magnetic permanence for the life of the installation. Available in range of sizes to meet every requirement.

Many of these units have been installed in power plants in the steel industry.



NEW GAS TORCH HAS HIGH GAS CAPACITY

▲ Air Reduction, manufacturers of industrial gases and welding equipment, has announced the availability of a new oxyacetylene scarfing torch for steel mill work. The new torch, complete with starting rod device, is the result of extensive field and laboratory research. According to the manufacturer, the torch offers the following advantages: High gas capacity—5,000 cu ft per hr at 100 psi. This extremely high flow rate permits maximum output per man hour; Lightweight — the torch, including starting rod attachment, weighs just six pounds, considerably lighter than any comparable torch now available. The light weight was achieved without sacrificing ruggedness, by making use of aluminum parts wherever possible and by the elimination of excess metal. Sturdy construction — The new Airco scarfing torch is constructed of stainless steel, monel and aluminum. The torch head is made of type 304 stainless steel, as are the tubes. Wear ribs, located on both sides of the torch head, are an added feature that will materially increase the work life of the torch.

ELECTRONIC CONTROLS FOR SPOT WELDING

▲ New electronic heat controls for spot and projection welders are now available in separate enclosures, through the Square D Co. Styling and dimensions of enclosures match electronic contactors or non-synchronous electronic timer-contactor combination controls. Class 8990 heat controls provide stepless adjustment of welding current from 20 to 100 per cent on 440 volt systems, or from 40 to 100 per cent on 220 volt systems.

The new design emphasizes a number of features important to industrial users. For maximum ease of servicing and maintenance, all components and circuit tie points are brought to terminals which are completely accessible simply by opening the enclosure door.

Tubes, warm-up timing relay, and all circuit components excepting a large capacitor and transformers are plainly visible when the enclosure door is opened. Disconnect plugs and ¼-turn fasteners enable the user to quickly remove the complete panel and power supply in one piece, without disturbing external connections. Soldered connections are eliminated, and only a screw-driver and pliers are needed to replace components.

The adjuster dial is covered by a small door which can be locked to

77-TON EXHAUST HOOD

The exhaust-hood for a 150,000 kw steam turbine is reversed for finishing operations in General Electric's Schenectady works. Two powerful overhead cranes were used to lift the 77 tons of steel. The turbine-generator of which this is a part will be capable of producing enough electricity to meet the needs of some 300,000 people. Each hour some 176,000 gallons of water in the form of steam will flow through the turbine.

PRODUCTION: UP
COSTS: DOWN

with A-B-K Laminated Plastic Bearings

● On all types of steel mill operations, A-B-K Laminated Plastic Bearings have proved their ability to support peak production—*and cut costs.*

Tough, resilient A-B-K Bearings actually *outwear metal.* They resist heat, acids and alkalies—will not distort under shock. And they hold gauge longer . . . reduce shutdowns for adjustments and replacements.

In addition, A-B-K Bearings are water-lubricated—require no oil or grease. Their ideal coefficient of friction reduces power consumption.

It will pay you to see how these advantages of A-B-K Laminated Plastic Bearings can be applied in your mill. An A-B-K representative will call with the full facts in response to your letter, wire or telephone call.

A-B-K slipper bearing with patented reinforced edge.

Phantom view of slipper bearing.

A-B-K roller neck bearing with separate collar.

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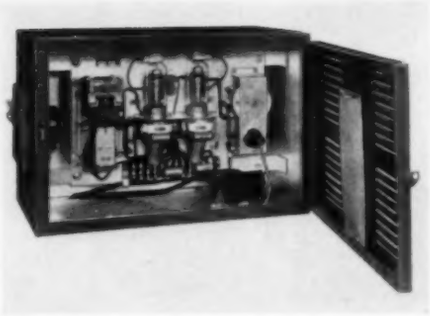
Laminated Plastic Bearings

AMERICAN **Brake Shoe** COMPANY

AMERICAN BRAKEBLOK DIVISION
DETROIT 9, MICHIGAN



The door covering the adjuster dial can be locked to eliminate tampering.

eliminate tampering. This construction protects the operator while making adjustments, since he doesn't open the main door to electrically live parts. Choice of ignitor firing tubes gives warm-up time of less than one minute.

Controls can be provided with an enclosed auxiliary heat adjuster and a transfer switch which permits selection of either dial setting from a remote location. For remote control from a single location, the adjuster rheostat may be removed from the control and separately mounted.

CFI PLANT USES NEW BLOWPIPE FOR CUTTING

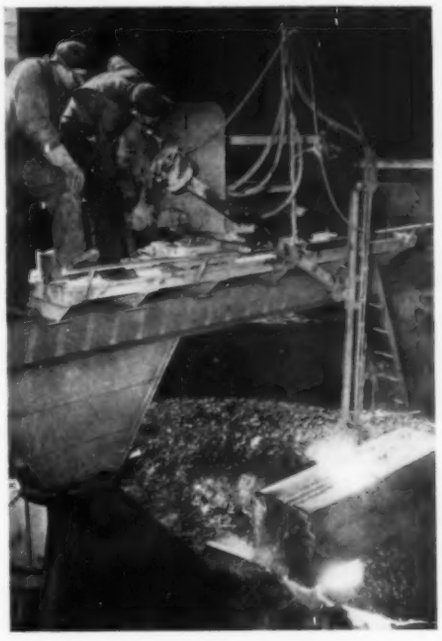
▲ Novel features of the scrap-cutting setup at the Colorado Fuel and Iron Corp.'s Pueblo, Colo. plant are shown in the accompanying illustration. The "Oxweld C-60," the world's largest cutting blowpipe, is mounted on a turntable unit and traversing carriage. Thus, the blowpipe is accessible to work in a wide area. A counterweight makes easy the raising and lowering of the blowpipe.

As pictured, the blowpipe is cutting lengthwise through an ingot 2 ft thick at a rate of 3 in. per minute. Metallurgists at Colorado Fuel and Iron state that with the installation of the new blowpipe, greatly increased studies of ingots will now be possible.

Although the new blowpipe will have varied uses for test purposes, its primary function at Pueblo, however, will be for cutting buttons and skulls. Heretofore, large buttons could not be reclaimed economically as scrap for use in the open-hearth furnace. Therefore, a large cutting blowpipe was needed in the slag yard which could reduce large buttons to charging-box size. The "Oxweld C-60" blowpipe is a product of Linde Air Products Co.

This blowpipe has been specially designed for extra-heavy cutting operations, such as the scrap-cutting of skulls and buttons. Continuous cuts through steel 68 in. thick have been made at Pueblo. This blowpipe, using the powder-cutting principle, is particularly well-suited to cutting scrap having more than a normal amount of cinder and slag inclusions.

In the powder-cutting process an iron-rich powder is blown into the oxygen stream from outside the preheat flame. Powder is heated to ignition temperature by the oxy-acetylene preheat flame. Refractory oxides are removed continuously by a melting and fluxing action as the cutting proceeds. By this process, materials oxidation-resistant to the normal oxy-acetylene flames are easily cut at speeds comparable to cutting equivalent thicknesses of carbon steels.



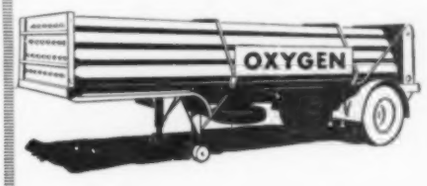
With the new blowpipe, greatly increased studies of ingots will be possible.

INDUSTRIAL FLOOR PAINT IS MOISTURE RESISTANT

▲ Alkali resistant floor enamels have been added to the standard Pittsburgh Plate Glass Co. line of paints. The new products will be marketed under the Pittsburgh finishing material label and are now available in two colors, pewter gray and tile red.

The new enamels are rubber base products for use on interior cement floors where conditions of dampness,

WHO PAYS THE FREIGHT?



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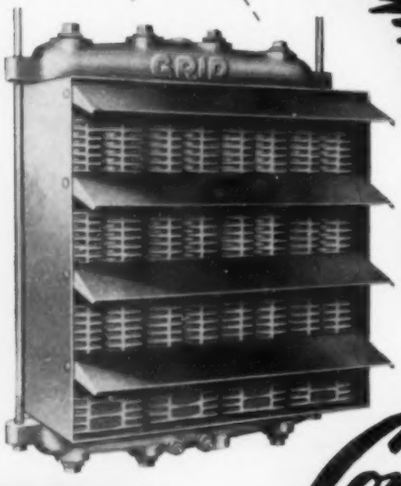

GRID CAST IRON Construction

HIGH TEST CAST IRON CONDENSER SECTIONS

YOU'RE SURE THAT THEY WILL STAND SEVERE SERVICE WITHOUT MAINTENANCE...

Gentlemen:
We have in service GRID Unit Heaters type No. 2500. A number of them have been in use for approximately 10 years and some of the units are on very severe service where the steam is turned on and off several times each day, the valves being turned on and off very rapidly. Even under this severe service we have found them to be maintenance-free.
Yours very truly
A MIDWEST STEEL MILL

Not only do GRID Unit Heaters stand up in service where steam is turned on and off several times each day—but even then they are maintenance-free while doing an efficient heating job. GRID Unit Heaters are designed to save fuel cost, too, because they provide heat where it is most needed—to the working zone. Careful selection of fans and motor speeds eliminates stratification of warm air at ceiling level . . . GRID Unit Heaters are designed for low outlet temperatures and greater air delivery to the floor line —**not the ceiling,** regardless of atmospheric conditions. GRID Unit Heaters are especially adaptable for cleaning rooms or any part of your mill where acids are used in process work . . . they withstand high corrosive atmospheres without maintenance. All steel mills using GRID Unit Heaters say "GRID is the best for us". Here's why—GRID "fin" heating sections are ONE piece construction high test cast iron—the metal for permanency . . . no electrolysis to cause corrosion, breakdowns, leaks or heating failures, because there are no dissimilar metals used in GRID construction. GRID Unit Heaters will withstand steam pressures up to 250 lbs. Investigate the GRID system of steel mill heating. It's different and time proved.

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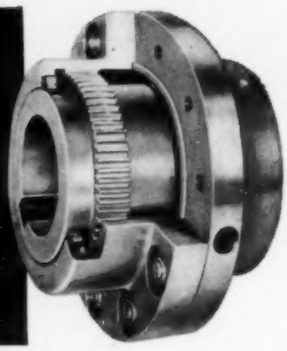

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ELIMINATES TROUBLE SPOTS OF ORDINARY DESIGNS

Solid Cover Sleeve Non-Welded
No danger of distorting accurate gear in sleeve.

No Metal-To-Metal Wear
to cause leakage and expensive repairs.

Hermetically Sealed
to protect lubricant from exposure to air and dust.

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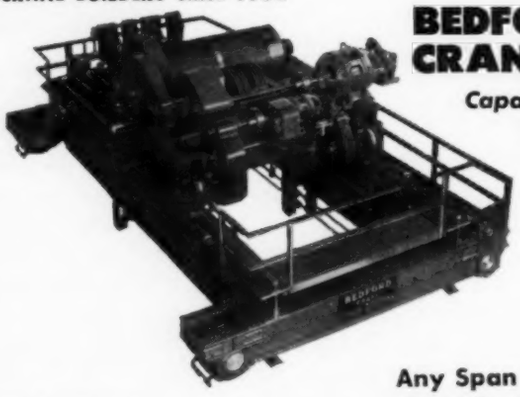

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Gray Iron Castings

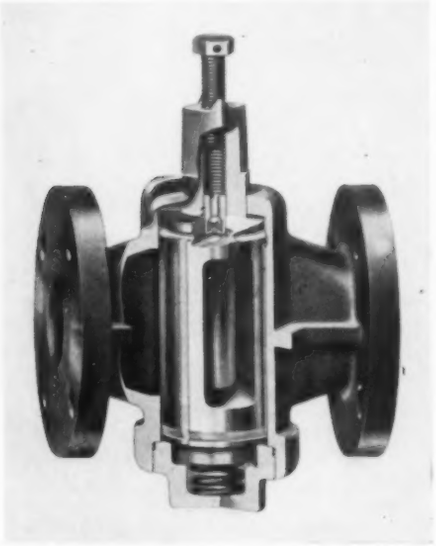
moisture, alkali or a combination of these elements are unusually severe. They are specifically recommended for use on areas located near chemical tanks, bottling machines, etc., where exposure conditions are often abnormal.

A companion product, a solvent reducer, is also being introduced by Pittsburgh Plate for removing wax and grease from areas prior to painting with alkali resistant floor enamel. The solvent reducer may be used as a thinner for rubber base enamels and for cleaning brushes or spray equipment used in their application.

LUBRICATED VALVE GIVES LONGER SERVICE

▲ A new lubricated plug valve that is said to give longer leakless service, because it automatically compensates for wear, is announced by Homestead Valve Manufacturing Co.

The cylindrical plug of the new valve, known as the Homestead-Reiser "Self-Seald Valve," has a wedge action which not only adjusts itself for wear, but also keeps the sealing surfaces of the plug and body in intimate contact at all times to provide an extra tight seal against



Port areas are equal to the area of standard pipe.

leakage, and lower lubricant losses. Line fluid pressure also acts on the plug to promote the sealing effect.

Among other features claimed for the new valve are port areas equal to the area of standard pipe; a complete lubricant seal around the ports; and positive, visible stops to limit operation to a quarter-turn.

CONTROL HANDLE ALLOWS EMERGENCY OPERATION

▲ An emergency control handle for CSP transformers making possible temporary emergency operation during overload periods when the transformer secondary breakers have tripped and dropped the load is announced by Westinghouse Electric Corp. Designed for times when it is impossible or inexpedient to replace an overloaded transformer immediately, the emergency control permits operation of the transformer during an emergency when accelerated insulation deterioration is of less importance than restoring the load.

The emergency control handle is a small red lever under the breaker operating handle normally sealed with a meter seal. When the seal is broken and the lever pulled down, the bimetal actuating element of the secondary breaker is readjusted so that it can carry higher overloads for a longer period of time. Even when so set, the circuit breaker will still give short-circuit protection. The red handle is normally not evident but when turned to the emergency position, it becomes conspicuous from the ground. The red signal light indicating overload continues to burn with the handle in operating position giving positive indication of critical overload conditions requiring attention as soon as possible.

Initially emergency controls will be standard equipment on all new standard CSP transformers 5- through 25-kva sizes inclusive and on REA CSP transformers in 7½- through 25-kva sizes inclusive.

DEVELOP ACTUATING UNIT FOR GATE VALVE USE

▲ Crane Co. has announced a simplified fluid-motor operator for gate valves. This new design makes possible extensive use of motor operated valves, since the actuating unit can be easily adapted to standard valves in stock or to valves already installed. This previously has been a virtual impossibility, for motor-operated valves have customarliy been made up on special order to the requirements of the installation. The device can be

operated by water, oil or compressed air or gases.

The motor unit, comprising the motor, gear box and yoke, is bolted to the valve bonnet; and the motor operates the valve stem through the gear box. The motor derives its power from five flexible diaphragms, mounted radially about an eccentric on the drive shaft. The operating fluid is admitted in rotational sequence to the five diaphragms, which actuate pistons that transmit the thrust to the eccentric through a roller bearing mounted on the shaft. By means of a suitable control, the operating fluid can be admitted through either of two entrance ports, controlling the direction of operation of the motor for opening and closing the valve.

When the valve gate reaches the end of its travel in either direction, the motor merely stalls, still under pressure. There can be no leakage, and shut-off devices are unnecessary.

The valves can be operated by a wide range of liquids or gases at pressures from 40 to 300 psi. The operating mechanism delivers a high starting torque and is adjusted to deliver a greater torque for unseat-

When you request more information say you read it in the
IRON AND STEEL ENGINEER

ing the valve than for seating it. A handwheel is furnished for manual operation in the event of pressure failure.

Valves equipped with the new fluid-motor operator are available in most types of Crane iron-body gate valves in sizes 4-in. through 30-in. Development is in progress on a motor for valves of still larger size. The wide choice of operating fluids and pressures for powering the fluid motor simplifies the problem of plant installation, since available fluid pressure sources may be utilized.

The new mechanisms are interchangeable with standard mechanisms.

DEVICE TO DOUBLE LIFE OF MOTOR BRUSHES

▲ A device which will more than double the life of brushes and commutators in series-wound, heavy-duty motors has been developed by engineers of General Electric's fractional horse-power motor divisions.

Designed for G-E fractional-hp motors used in portable electric tools, the new brush stabilizing mechanism counteracts the wedging effect of the commutator and causes the brush to ride freely in the brush holder.

The device, the engineers said, makes it possible to retain overload capacity of series motor parts and at the same time greatly increase brush life through the elimination of reflected vibration to the brush and the "wedging" of brush against brush holder by the force of the rotating commutator.

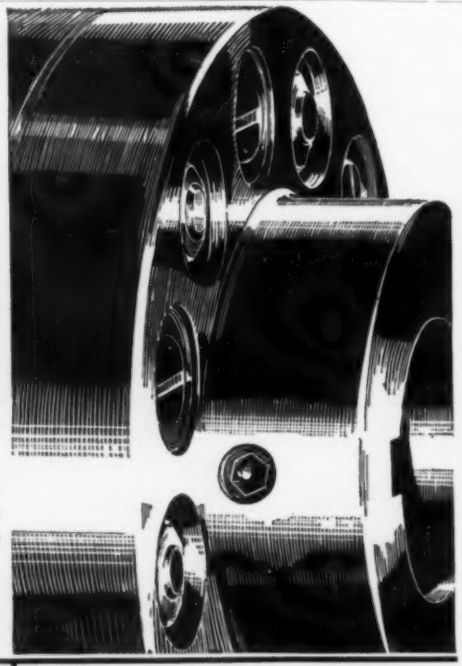
The new mechanisms, they said, have been designed to interchange with standard mechanisms as outlined in the NEMA standardization of series-wound motor parts.

The normal cartridge type of brush holder as used on portable tools consists of a brush holder, insulating tubing, brush and spring assembly, and a brush cap.

The change to a brush stabilizing mechanism involves the use of an angular brush top plus the addition of a bracket to seat on the angular brush top. The brush spring pressure is thus partially resolved into a horizontal component which corrects the brush wedging and thus improves commutation and increases brush life.

The addition of a roller to the bracket assures close following of the brush on the commutator resulting in improved commutator life.

The G-E line of Type BA heavy-duty series motor parts will be available with and without the new mechanism. Special applications to other types of motors using a cartridge type mechanism also are expected.



Ajax design permits installation vertically or horizontally. No lubrication.

Remember that all the horsepower goes through the coupling... put it up to Ajax.

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Regardless of type, Smeeth-Harwood techniques produce dense, fault-free walls of uniform thickness.

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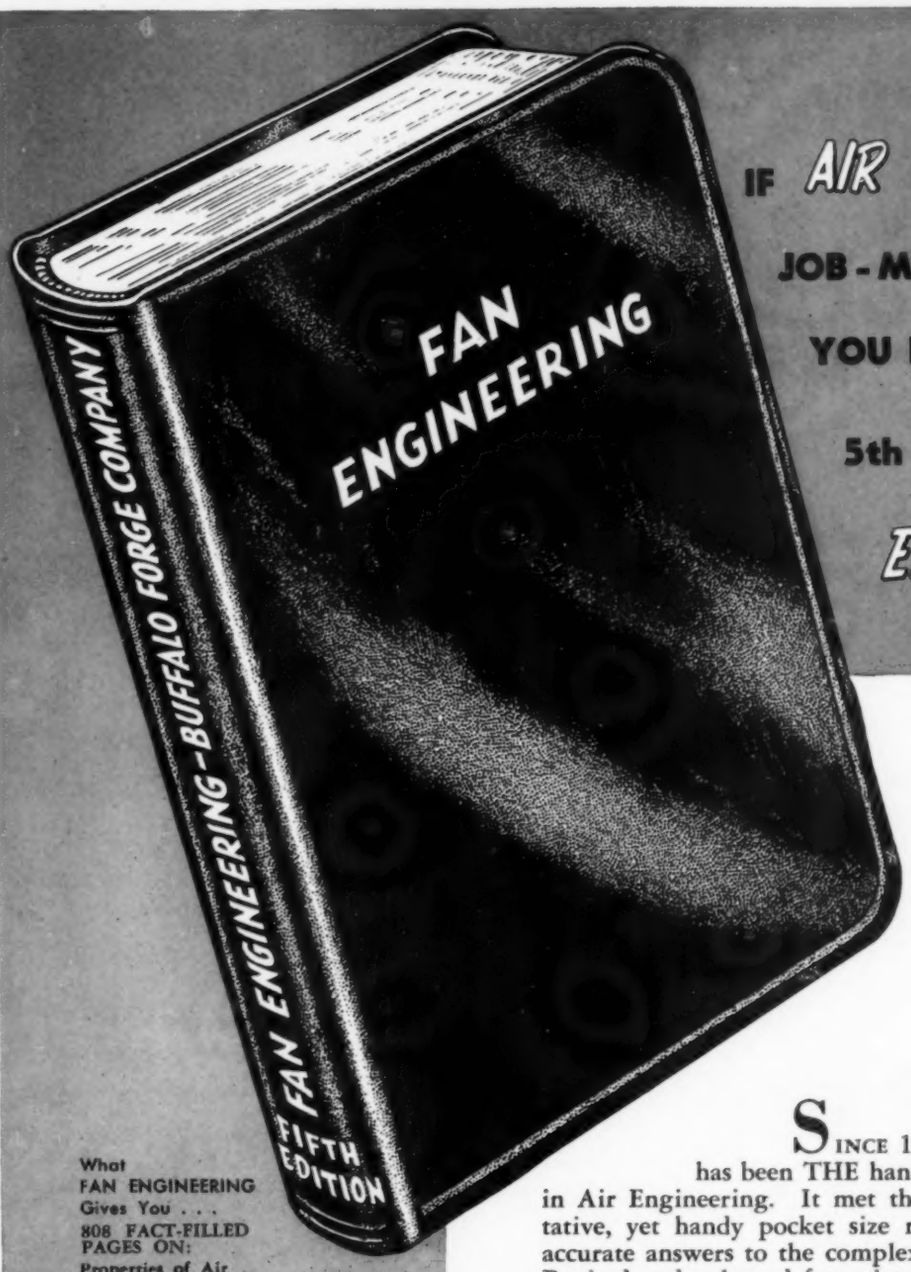

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DRAFT BLOWER USES MOTOR OR TURBINE DRIVE

▲ L. J. Wing Mfg. Co. announces a new forced draft blower, incorporating a combined electric motor and steam turbine drive. A change from one drive to another can be made at will. The basic unit is the Wing Type "R" turbine blower with a totally enclosed, dust-proof motor connected to an extension of the turbine shaft. A choice of drive may be governed by consideration of heat balance, more economical operating costs, or emergencies affecting the source of power. To operate, you simply throw a switch for electric drive or turn a couple of valves for steam drive. Wide range of control is available with both drives. Throttling gives speed control of the turbine and Wing Voltrol Vanes permit capacity regulation for the motor drive. Automatic operation of both drives may be arranged in connection with a combustion control system. The entire unit is extremely compact, and saves considerable space when compared to older designs.

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▲ A new Bailey swing check valve, said to be an effective and dependable safety device for cold blast lines of blast furnaces, is made by William M. Bailey Co.

Installed in the cold blast line between the blowing room and the mixer line connection, the new valve eliminates the danger of destroying equipment by fires and explosions. Designed and built especially for steel mill service, the swing check valve acts instantly and automatically to prevent reverse flow in the event of blast failure, thereby guarding against costly shutdowns.

The swing check valve is a fully-enclosed non-return valve of the

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Book Reviews

▲ The following revised editions of existing NEMA Standards have now been published and copies are available for distribution:

NEMA Standards for Power Switching Equipment, Publication No. 49-144. This revised publication supersedes the previous edition, Publication No. 45-94. It contains rating, manufacturing and application standards for bus supports and air switches; rating, performance and application standards for air interrupter switches; and application standards for outdoor substations. The terms used throughout the standard are defined, and instructions for the installation, operation and care of power switching equipment are given. 67 pages, 8½ x 11, $3.00.

NEMA Instructions for the Care and Maintenance of Oil-Immersed Transformers, Publication No. 49-143. The instructions apply to oil-immersed transformers rated above 100 kva, below 15,000 v, and all sizes above 15,000 v and to distribution transformers rated 100 kva and smaller 15,000 v and below. The location, storage, handling, inspection, drying core and coils, sampling and testing of oil, drying oil and filling transformer, maintenance of artificial cooling systems and temperature as applied to oil-immersed transformers are covered. 15 pages, 8½ x 11, $0.60.

EEI-NEMA Preferred Voltage Ratings for a-c Systems and Equipment, NEMA Publication No. 117. The voltage zones of system voltages as determined by a survey of voltage conditions existing on power systems ranging from 120 to 230,000 v., inclusive, and corresponding equipment voltage ratings are set forth in this report. The tables contained in the publication deal with preferred voltage ratings for capacitors, measuring instruments and electricity meters, appliances, lamps, devices, motors and control equipment, generators and synchronous condensers, switchgear, instrument transformers, power transformers, distribution transformers, lightning arresters, power cables and potheads and feeder voltage regulators. 34 pages, 8½ x 11, $0.70.

▲ A set of charts of compressibility factors for hydrogen, nitrogen, and oxygen, together with charts showing quantities of these gases delivered by commercial cylinders, has just been published by the National Bureau of Standards. This set of six charts will be of interest to anyone who either uses or handles hydrogen, nitrogen, or oxygen gases.

The first three charts give directly the number of standard cubic feet of gas which a commercial cylinder will deliver. The remaining three give the compressibility factor $Z = pV/nRT$. The use of the compressibility factor Z is a convenient method of correcting for deviations of actual gases from the ideal gas laws, permitting accurate calculations of pressure, volume, or mass of gas when those laws do not apply because $Z = 1$ for an ideal gas when p, V, n, R and T are expressed in self-consistent units. The pressure range of the Z-charts is from 0 to approximately 6000 psi at temperatures from —50 to + 150 F. The commercial-cylinder charts cover temperatures between —10 and + 130 F and a pressure range which varies with temperature between the approximate limits 1300 and 2800 psi. In addition to the charts, a brief text is supplied, containing a table of gas-cylinder sizes and several examples of the solution of practical problems by use of the charts.

Miscellaneous Publication M191, *Charts of Compressibility Factors and Charts Showing Quantities Delivered by Commercial Cylinders for Hydrogen, Nitrogen, and Oxygen*, by Harold J. Hoge, Cyril H. Meyers, and Robert E. McCoskey, containing six charts (31 x 24 in.) and descriptive pamphlet, obtainable from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C., 25 cents. Remittances from foreign countries must be in U. S. Exchange and must include an additional sum of one-third the publication price to cover mailing costs.

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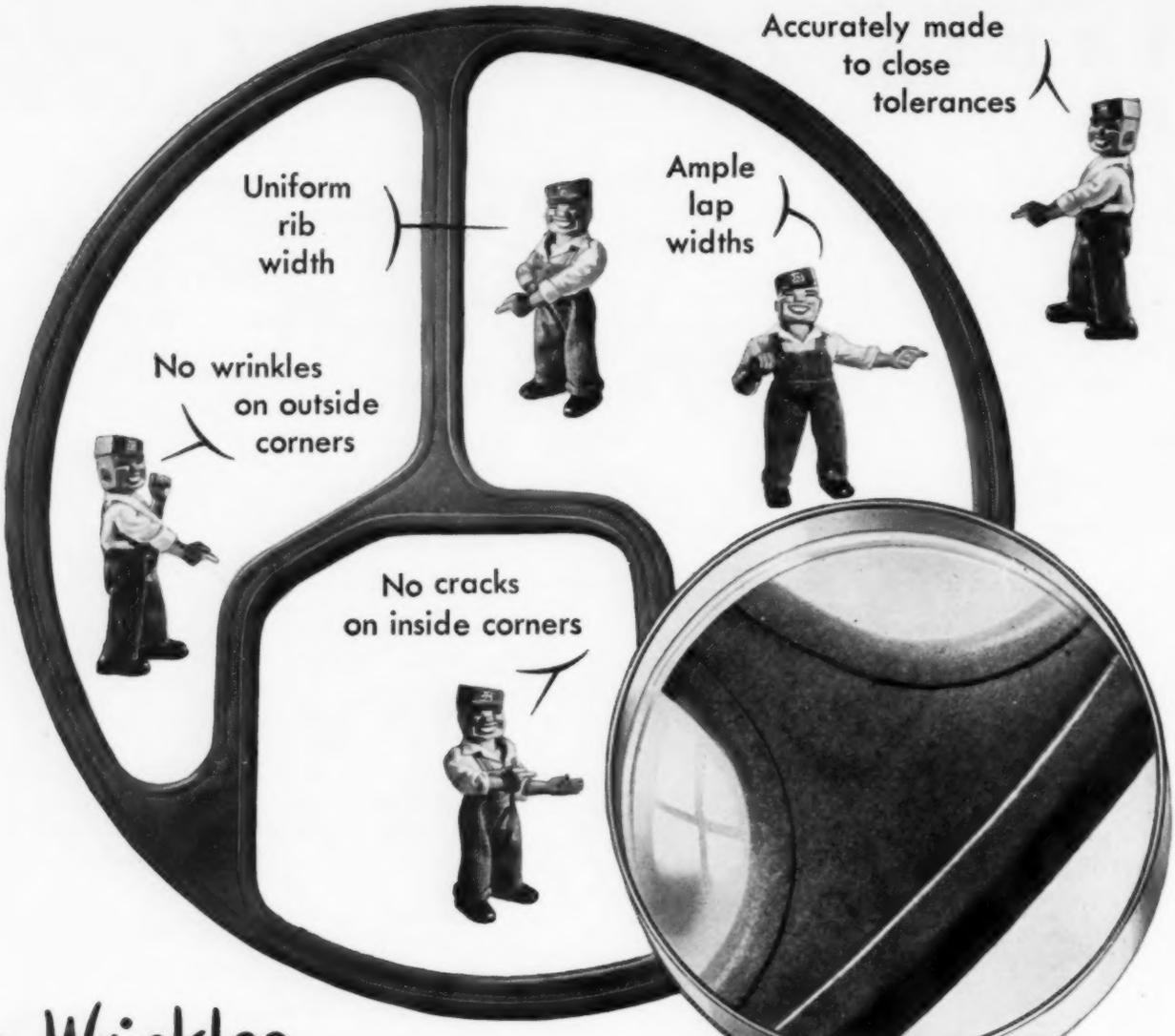
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